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## ASTRONOMICAL RESEARCH IN INDIA: II

IN *Current Science* for July 1943, a plea was entered for the promotion of astronomical study and research of the highest grade in our country. We require, in the first place, the establishment of observatories in different parts of India staffed by competent and enthusiastic astronomers and equipped with instruments capable of yielding results of real interest and importance. From Kashmir in the north to Trivandrum in the south, from Shillong in the east to Karachi in the west, the territories of the Indian Empire include a variety of latitudes, elevations, climates and observing conditions. A selection could be made of possible locations for a group of observatories which between them could cover the heavens in systematic programmes of exploration and study, all the year round. Then again, the Universities in India should take steps to give astronomical studies and research a proper place in their activities, instead of relegating them, as at present, to an unimportant and practically negligible status.* Astronomy can have no future in India, unless opportunities are given to talented young men to interest themselves in the subject at the Universities. It is necessary also to take steps to encourage and develop public interest in astronomy. Every city of any importance in India should maintain at public expense an observatory of reasonable dimensions which would be open to the public free of charge. Such an institution would be a cultural centre where even the humblest individual who desires to do so could acquaint himself at first hand with the facts of astronomy. There should also be societies and groups of amateur astronomers in every province to maintain and develop an active interest in the progress of astronomical science, by regular meetings, discussions and public lectures.

The programme outlined above presupposes many things—an enthusiasm for astronomy, a willingness to work for its progress, the desire and ability to find the money needed for its active promotion, and above all an atmosphere in which the pursuit of the science could flourish and not be regarded as a useless luxury. It might be urged that a poor country in which the vast majority of the people live at or below the marginal level of human existence, should not trouble itself about astronomy—a non-utilitarian pursuit, as some might be disposed to regard it. To convert those who hold this view to a different state of mind, it might be useful to point out clearly the enormously important part that astronomical studies have played and are playing in the development of both scientific knowledge and general culture. That astronomy occupies the premier position amongst the sciences will be evident if we recall its organic relationships with the other sciences. The basic idea of all science is the concept of law in Nature—the view which regards natural phenomena as an ordered sequence of events linked together by a chain of causation. This concept is an intellectual conviction which established itself in the first instance from the observational facts of astronomy, including especially the most familiar of them all, such as the daily rising and setting of the sun and the moon, the variation of the seasons, the predictability of eclipses and the like. The fundamental ideas which lie at the basis of all the sciences, *viz.*, the notions of time and space, matter and gravitation, light and darkness, heat and cold, all come to us as part of the astronomical environment in which we live. The deeper we delve into the various branches of natural knowledge, the more clearly do we perceive that everything on this earth and inside it, both in the remote past and in the immediate present, has been determined by the astronomical history of our planet. The

* The Osmania University at Hyderabad is an honourable exception in this respect.—C. V. R.

structure and functions of every living object on the face of the earth and the rhythm of its daily life bear the imprint of our astronomical environment and history in language which can be read very plainly.

The pursuit of astronomical studies in any country has an enormously stimulating influence on other branches of scientific investigation. Consider, for instance, that most abstract of all sciences, mathematics. A long roll of illustrious names in the history of science could be cited to indicate how the facts of astronomy and the attempt to interpret them furnish the motive power for the development of new kinds of mathematical thought. Just to mention, Archimedes, Bhaskaracharya, Kepler and Newton should be a sufficient lesson to us from the history of the past. The contents of Newton's immortal work, the *Principia* opened up a new world of thought alike in the regions of mathematics, astronomy and physics. Laplace and Einstein may be mentioned amongst the intellectual giants to whom the facts of astronomy were at once a challenge and an inspiration to develop new ways of mathematical thinking. An astronomical theorist has, of necessity, to be a first-rate mathematician, but his work benefits not only astronomy but all fields of science in which analogous methods could be applied. A striking illustration of this is the recent work of Chandrasekhar on the dynamical theory of stellar systems. As a published report by him reveals, the mathematical developments he has initiated are applicable also in the realms of molecular physics and of colloid chemistry!

As every physicist knows, the study of the stars and the study of the atoms are only two different phases of the attack on the fundamental problems of his subject. In the July article, mention was made of the discovery of the finite velocity of light by Romer, of aberration by Bradley, of laws of planetary motion by Kepler, of the dark lines in stellar spectra by Fraunhofer, of helium in the sun by Lockyer, of the magnetic field in sunspots by Hale, and of the recession of the nebulæ by Hubble. These are typical examples of what might be called the purely observational discoveries of astronomy, which have exercised a profound influence on the orientation of physical thought. Such a list could be extended almost indefinitely. We may put the situation briefly by saying that the Universe is a physico-chemical laboratory of cosmic dimensions and that we are privileged to watch through our giant telescopes a never-ending succession of experiments made on a scale and under conditions which we could never hope to reproduce with our comparatively Lilliputian resources. What we see has much to teach us. It forces us to think deeply. With minds strengthened and refreshed by new ideas, we look again through the telescopes and understand better what we see. But that is not all. The facts of astronomy suggest new modes of attack on the problems of experimental and theoretical physics. When, for example, Niels Bohr set out in 1913 to solve the problem of atomic structure, he found his inspiration in the work of Copernicus, Kepler and Newton. His astronomical model of the hydrogen atom with the electron going round the nucleus in an elliptic orbit as the earth goes round the sun was a magnificent success. As every student of physics and chemistry knows, it opened up great new vistas of physical and chemical thought. To-day, the physicists are watching the skies to discover, if possible, the origin of the mysterious cosmic rays which have meant so much to them in every possible way!

Chemistry is a subject of vast practical importance, and to the uninitiated, it might seem that it could have nothing in common with the science of astronomy which lives with its head up amongst the stars! It is useful to dispel such an illusion if it exists in the minds of any. The vital link between chemistry and astronomy is to be found in the problems of the origin of the elements, of their abundance, and of their associations and segregations, all of which are of the utmost importance not only to the chemist, but also to the geologist, the mining engineer and the metallurgist. The spectroscope reveals that all or nearly all the elements present in the earth are also present in the stars. Even the mysterious nebulium proved to be nothing more mysterious than oxygen and nitrogen under somewhat unfamiliar conditions. The problem of the origin of the elements is, therefore, not so much a terrestrial problem as an astronomical one. The transmutations of the chemical elements successfully effected, though on a very minute scale, in the atom-smashing laboratories of the world suggest that such or other analogous transmutations are in progress in the cosmic crucibles which we call the stars. Indeed, the suggestion has been made (and is probably well-founded) that such transmutations are the origin of the tremendous outpouring of energy continually going on from the sun and the stars. Such extra-terrestrial knowledge cannot but prove ultimately of the highest value and importance to terrestrially-minded capitalists and *entrepreneurs* of industry!

The tremendous interest aroused at the time by the observations of Lowell at the Flagstaff observatory on the planet Mars may be cited as an indication of the possible or probable relations between astronomy and the as-yet-unsolved problems of the origin and distribution of organised life. There can be little doubt that the history of life on the earth as illustrated in the record of the rocks was to a great extent determined by the astronomical history of our planet. There is striking evidence in the record of notable climatic changes and associated with them also of the disappearance of some of the older forms and the appearance of newer forms of life from age to age. It cannot be assumed that the evolution of life on the earth has come to an end. Far from this being the case, man is now keenly interested in the process and is taking an active part in the creation or development of new plants and even new animals, which could be of service to him. Can it be assumed that the radiations of various kinds received by the earth from space play no part in biological evolution? Probably not. Be this as it may, no geologist or biologist afford to ignore what astronomy can tell him about the past, present and future of the earth.

Let us leave science now and consider for

a moment the cultural aspects of astronomical study. Can it be denied that astronomy is the noblest and the grandest of the sciences, that it takes us away, if only for a while, from the noise and the dust of terrestrial conflicts and leads us to a better comprehension of the universe we live in and its eternal verities? Our politicians and philosophers are constantly reminding us of India's great spiritual heritage. Should they not raise their voice also to remind us of India's intellectual heritage as reflected in our age-old interest in astronomy, and help to build up a renewed and active interest in its study?

C. V. RAMAN.

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# POST-WAR ORGANISATION OF SCIENTIFIC RESEARCH IN INDIA

A SYMPOSIUM on Post-War Organisation of Scientific Research in India was held under the auspices of the National Institute of Sciences of India on the 27th and 28th September 1943, in the hall of the Royal Asiatic Society of Bengal, Calcutta.

As a result of the discussion the following tentative proposals regarding the formation of a National Research Council were adopted. It was decided further that these proposals be circulated to the Government Scientific Departments, Universities, learned societies and unattached institutions for expression of their views, and discussed, with a view to their being given effect to, at another symposium meeting to be held at Delhi towards the end of the year at which representatives of the relevant organisations would be invited to be present.

I. The Council of the National Institute of Sciences of India be authorised to take necessary steps for the organisation of a National Research Council constituted under the statutory authority of the Government of India. The National Research Council shall be directly responsible to the Government and have the following functions:—

(*a*) To plan the main lines of scientific work in accordance with national needs, to formulate schemes for the above purpose, to review and modify the same whenever necessary and to recommend ways and means for implementing the results of accomplished researches.

(*b*) To ensure balanced development of all branches of science, and minimise overlapping.

(*c*) To advise and help relevant authorities regarding the training and supply of scientific personnel for pure and applied research.

CONSTITUTION

*National Research Council.*—The National Research Council shall consist of scientific and technical experts not exceeding sixty in number, the majority of whom shall be elected by non-official scientific organisations, including Universities and institutions of University rank, the remaining number being nominated by the Government of India from among the scientific and technical experts. The President of the National Research Council shall be nominated by the Government of India from among the members. A Vice-President shall be elected by the National Research Council from among its members. A whole-time salaried Secretary shall be appointed by the National Research Council for carrying on its work, who will not be a member of the Council.

*Governing Body of the National Research Council.*—There shall be a Governing Body of the National Research Council which shall consist of the following: The President and Vice-President of the National Research Council, and the Chairman and Vice-Chairman of each of the Boards.

*Boards of Research.*—For the performance of its functions the National Research Council shall constitute the following Boards of Research from among its own members, each of which will be responsible, within its own particular sphere, for giving effect to the policy of the National Research Council:—

(1) Board of Scientific Research,
(2) Board of Agricultural Research (Soils, Crops and Animal Husbandry),
(3) Board of Medical and Public Health Research,
(4) Board of Engineering Research, and such other Boards as may be considered to be necessary.

The maximum number of members of each of the Boards of Research shall be fifty. The National Research Council shall appoint the Chairman and Vice-Chairman for each Board and shall co-opt eminent scientific workers in different branches in consultation with non-official scinetific organisations, Universities and institutions of University rank, scientific departments of the Government, and Federations of Chambers of Commerce.

*Research Committees.*—For the performance of its work, each Board will be authorised to constitute Research Committees for all important subjects, to settle the objectives of research, indicate the individuals or organisations which could undertake the several component parts of the enquiry, receive, and co-ordinate the resulting information, make it available to those who will turn it to advantage and to form a national plan into which all who are in a position to contribute information can fit the particular lines of research. Governing Bodies of National Research laboratories, when established, shall be constituted in consultation with the relevant Research Committees.

II. The Government of India be requested to form development corporations for the performance of functions analogous to those performed by the Research Enterprises Ltd., in Canada. The National Research Council shall be represented on the Governing Bodies of the development corporations.

III. To enable effect being given to the policy of scientific development determined by the National Research Council, the Government of India should make grant of five crores of rupees per annum.

# COCONUT SHELLS AS AN INDUSTRIAL RAW MATERIAL

## I. COMPOSITION OF SHELLS

By Dr. REGINALD CHILD
*(Director, Coconut Research Scheme, Ceylon)*

THE object of these articles is not so much to report new observations (though the preliminary results of some unpublished work are included) as to review the properties of coconut shells and to examine their status as a potentially valuable raw material.

### Composition

(i) *Moisture.*—The moisture content of shells varies considerably with conditions and with maturity. Under average conditions air-dried mature shells contain 6 to 9 per cent. of moisture[1,2] and thus retain less moisture than most woods. This is an important point in connection with dry distillation (see subsequent article). All analytical figures quoted in the following discussion are given as percentages of dry material, unless otherwise stated.

(ii) *Ash.*—Figures ranging from 0·23 to 1·425 per cent. have been recorded; recent references give values based on dry weight, but in the older citations it is not usually clear whether or not the results have been so corrected. The following is a selection of analytical figures from the literature:—

| Authors | Reference | Date | % Ash | As percent. of ash | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $K_2O$ | $Na_2O$ | CaO | MgO | $Fe_2O_3$ + $Al_2O_3$ | $P_2O_5$ | $SO_3$ | $SO_2$ |
| Fleck *et alii* .. | 1 | 1937 | 0·23 | — | — | — | — | — | — | — | — |
| Bachofen .. | 12 | 1899 | 0·29 | 45·01 | 15·42 | 6·26 | 1·32 | 1·39 | 4·64 | 5·75 | 4·64 |
| Phillips and Goss .. | 4 | 1940 | 0·55 | — | — | — | — | — | — | — | — |
| Child and Ramanathan .. | 2 | 1938 | 0·61 | — | — | — | — | — | — | — | — |
| Georgi . | 5 | 1941 | 0·69 | 52·20 | — | — | — | — | — | — | — |
| Norris (quoted by Sampson) . | 3 | 1923 | 1·10 | 31·6 | — | 2·97 | 3·87 | — | 5·32 | — | — |
| Lépine (quoted by Copeland &c.) | 13 | (1861) | 1·41 | * | — | * | — | — | * | — | — |
| Fesca .. | 16 | 1904 | 1·425 | 30·0† | — | 2·32† | 1·12† | — | 5·00† | — | — |

* 86·94 per cent. of "salts of K"; 2·18 per cent. of calcium phosphate; "salts of Ca" 6·53.

† Calculated from the figures given in Preuss (*loc. cit.*) as the percentages on the original shell, assuming an ash content of 1·425%.

Doubtless the percentage and composition of the ash vary with soil and climatic conditions, habitat and variety of palm; thus the nuts examined by Bachofen and by Child were of Ceylon origin; by Norris from Madras Presidency; by Georgi from Malaya; and by Phillips and by Fleck possibly from the Philippine Islands. Maturity of the nut also affects the composition of its component parts, and Copeland (*loc. cit.*, p. 174) remarks that "Bachofen's nut cannot have been thoroughly ripe"; there seems, however, little reason for this statement.

The figures of Bachofen and the still older results of Lépine have been extensively quoted in the literature. Great confidence can hardly be reposed in those of Lépine, which (see Bibliography) appear to date back at least to 1861, but those of Bachofen are useful, pending the collection of further data, in that they give at least some idea of minor constituents.

In the writer's experience in Ceylon, an ash content of 0·6 per cent. is usual. Coconut shell charcoal is required by some specifications (see second article) to contain not above 2·0 per cent. by weight of the original shells; this implies a maximum of 0·67 per cent. ash on the latter and the writer has, in the course of examining many samples of charcoal, never found this limit exceeded with uncontaminated samples. Potash is clearly the principal constituent of the ash. The salts will largely be present as carbonates, but phosphate, sulphate and silicate also occur, as well as chloride. It is curious that chloride estimations have not been recorded; the writer's (unpublished) analyses of charcoal samples indicate the presence of 1 to 2 per cent. of Cl[1] in the ash.

About 90 per cent. of the ash is water-soluble, and the present writer[2] has also shown that most of the potash is extracted from the powdered shells by hot water.

The ash content is comparable with that of most woods; the large proportion of soluble ash is an advantage in the preparation of activated charcoal, since it is easily removed.

Georgi and Gunn Ley Teik[15] report the following average figures for eight lots of shells averaging 20·2 per cent. moisture (*i.e.*, not air-dried but as collected): $K_2O$ 0·364, CaO 0·009, MgO 0·014, $P_2O_5$ 0·035. They do not, however, state the actual ash contents, so that their figures cannot be collated with the above table; from inspection of the figures it looks as though the ash content would have been considerably higher than 0·6 per cent.

(iii) *Organic Constituents.*—An early analysis is that of W. L. Winton[6] in 1901, who employed the ordinary methods of Food and Drug examination for the detection of powdered coconut shell in species which adulteration he stated to be a common practice in the United States. His figures are not now of particular interest; a value of 56·19 per cent. was recorded for "crude fibre", but this is now known to have little definite relation to the structural constituents of the original material. Curious figures of Brandes, quoted by Hunger[14] are of little value.

More adequate proximate analyses have been published by Fleck[1] (1937) by the present writer[2] (1938), and by Phillips[4] (1940). The original papers should be consulted for details; the chemistry of cell-wall substances is in an active state of development and methods of analysis are still somewhat empirical. However, the three sets of observations quoted are in fair agreement over the main features of the composition of coconut shells.

(*a*) *Solvent Extractives.*—Only small quantities of material are extractable by non-hydroxylic solvents, 0·19 per cent. by ether,[1] and 0·27 per cent. by benzene.[2] Alcohol has been found to extract 2·51 per cent.[2] and a 1:2 alcohol-benzene mixture 4·56 per cent.[4] The manner in which coconut shells burn has given rise to the supposition that they contain considerable quantities of oily or resinous matter; this is seen not to be the case. The nature of the solvent extracts has not been examined, but the alcohol extract presumably contains some tannin matter.

Cold water has been reported to extract 1·43 per cent.,[1] and 0·20 per cent.,[2] and hot water 2·67,[1] 3·57[2] and 2·76.[3] 1 per cent. caustic soda removes 20·53 per cent. of material[1] or 18·80 per cent.;[2] and 1 per cent. hydrochloric acid, 29·69 per cent. These figures are of limited theoretical value, since the alkali- or acid-soluble fractions are not clearly defined; the former, for example, includes part of the lignin and of the polyuronide and cellulosan fractions.

(*b*) *Nitrogen.*—Georgi and Gunn Ley Teik[15] give the analysis of eight samples as 0·073 to 0·090 per cent. (average 0·081 per cent.) for shells having a moisture content of 20·2 per cent. (not air-dried but fresh collected). This corresponds to an average per cent. nitrogen on dry weight of 0·10 per cent. and agrees well with the 0·11 per cent. reported by Phillips.[4]

A somewhat higher figure, 0·156 per cent. is given by Fesca.[16] The nitrogen seems to be largely associated with the lignin fraction (see below).

(*c*) Lignin.—The percentages of lignin reported are 33·30,[1] 36·51[2] and 27·26 per cent.[3] Methods of determination were all different and there may, of course, have been some natural variation between the samples examined. In the writer's opinion a figure of 32·0 per cent. is, probably, fairly near the true value.

Phillips gives a figure of 0·29 for the percentage of nitrogen in the lignin; this accounts for over 70 per cent. of the total nitrogen (see above).

*Methoxyl.*—The methoxyl content of shells has been reported as 5·39[1] and 5·84 per cent.[3] According to Phillips,[3] the lignin fraction contains 16·17 per cent. methoxyl or 16·46 per cent., calculated on the nitrogen and ash-free lignin. This accounts for 4·41 per cent. of the original. It does not, however, follow that the balance of about 1 per cent. methoxyl is associated with the non-lignin constituents of the shells, since it is by no means certain that there is no loss of methoxyl during the isolation of the lignin by strong acid treatment.

The lignin content of the shells is higher than that of most woods. Further reference is made particularly to the methoxyl content in the discussion of the distillation product of shells in a subsequent article.

(*d*) *Total Pentosans.*—Both Fleck[1] and the present writer[2] estimated pentosans by the method of Schorger, and obtained similar figures, *viz.*, 30·28 and 29·27 per cent. respectively. These figures were not corrected for the presence of polyuronides. Phillips[3] determined uronic acid anhydrides as 3·82 per cent. and used an empirical formula to give a correction for the amount of furfuraldehyde derived from the uronic acids; this correction came to 1·42 per cent. calculated as pentosans, and his so corrected "total pentosans" figure to 30·14 per cent.

The estimates of "total pentosans" by the three sets of workers are thus reasonably concordant. The percentage is considerably higher than in most woods and is the highest recorded for all nut-shells so far examined,[7,8,4]

No further quantitative details are available regarding the nature of the pentosans, but as long ago as 1895 Tromp de Haas and Tollens[11] obtained a "satisfactorily yield" of crystalline xylose by hydrolysis of coconut shells with 4 per cent. sulphuric and stated that this appeared to be the only product of the hydrolysis. The residue gave dextrose on further hydrolysis with stronger acid.

(*e*) *Cellulose.*—Published estimates of "cellulose" differ considerably and it is obvious that this is largely due to the methods of estimation and that the various workers were not dealing with similar "cellulose" fractions. Phillips'[3] use of the method of Kürschner and Hanak[9] seems to imply his opinion that the Cross and Bevan method or modification thereof as used by Fleck[1] and by the present writer[2] is less reliable for resistant materials like coconut shells. The wide discrepancies between the recorded percentages of "crude cellulose" become less serious when adjustment is made for the pentosan content. All the three workers determined the furfuraldehyde yield of their "crude cellulose" and calculated the pentosan content in the usual way based on Krober's work:

| | Fleck (1) | Child (2) | Phillips (3) |
|---|---|---|---|
| % Crude Cellulose .. | 44·98 | 53·06 | 33·52 |
| ,, Pentosan in Cellulose .. .. | 17·67 | 20·54 | 5·26 |
| ,, Cellulose .. | 27·31 | 32·52 | 28·26 |

It would appear, therefore, that the "crude cellulose of each worker differed materially only in that the respective methods of treatment had removed more or less of the pentosan fraction.

No further examination of the nature of the "cellulose" has been carried out, except that Fleck determined the arbitrary "Hydrolysis No.", *i.e.*, the percentage loss in weight after hydrolysis with 15 per cent. sulphuric acid, which he found to be 35·85. It may be noted that this is not markedly different from his figure for the pentosan

content of the cellulose. Fleck also determined the "holocellulose" fraction by the method of Van Beckum and Ritter;[1] this fraction, 61·0 per cent., purports to represent the entire non-lignin constituents of the cell-wall, and indeed does accord reasonably well with an estimate of 32·0 per cent. for lignin, allowing also for ash and extractives.

Further examination of "cellulose" fractions obtained in various ways seem to be desirable and a critical examination of methods of preparation. It seems safe to say, however, that the cellulose content of coconut shells is lower than that of most woods.

Boswell[8] noted that the cellulose separated from Brazil nut-shells was obtained as a hard mass whatever method of drying was used, and the writer has made a similar observation on cellulose derived from coconut shells, which was always obtained as a hard horny mass.

(*iv*) *Discussion.*—Qualitatively, coconut shells resemble, in composition, the hard woods, but they have higher contents of lignin, total pentosans and pentosan in cellulose, and lower contents of cellulose. The methoxyl content does not differ greatly from those of many woods. The nature of the products obtained by dry distillation (described in a subsequent article) show considerable quantitative differences from those of woods, and it is likely that these differences point to features in the composition of the raw material not indicated by existing analytical methods. It is believed that further investigation of the various fractions—lignin, "cellulose", pentosan, etc.,—would yield results of interest in the chemistry of cell-wall substances. This is probably also true of other nut-shells, few of which have been studied (see Refs. 7, 8, 4), but which present several novel points of interest.

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## INDIA'S POST-WAR INDUSTRY

THE question of capital re-equipment of Indian industry was raised by Sir Azizul Haque, Commerce Member, in his opening address to the meeting of the Post-War Reconstruction Policy Committee on Trade and Industry, on Thursday, the 21st October 1943. "The Government of India", he said, "have by no means lost sight of this aspect of the problem which the continuation of the war, with a consequent continuation of excessive wear and tear on plant, and increased difficulty of replacement, has made more acute. In so far as those machineries and plants have to be imported from abroad, I am convinced that no time should be lost in making an aggregate estimate of India's total post-war requirements. It will be necessary, without any avoidable delay, that the Governments or organisations of exporting countries must know the approximate extent of India's post-war requirements."

All industries are asked to take up this question as soon as possible so that the Government of India might take the necessary steps in that direction. It was the duty of the Government to assist new industry and new enterprise, but the Government must also look to trade and industry to state what were likely to be the scope and prospects of such new industries. "In the exigencies of war conditions industries are necessarily organised, mobilised, and shaped to meet the exigencies of war production, but it is time for us to try to plan the future, assess the place of these war industries in post-war conditions, and give our thoughts to other human and social aspects of life, and conditions of industrial labour so that men may not decay with a mere accumulation of wealth."

Therefore, Sir Azizul added, the Government were submitting to industries for their consideration a draft questionnaire which would give them the information they sought. He also emphasised that the questionnaire was a purely provisional document, and if the industries thought that some other method of getting the necessary information was to be preferred, they could give their views. The Committee decided the terms of a questionnaire to be addressed to industries to elicit factual data on which definite plans for post-war developments could be based. It also discussed India's trade policy in the post-war period, and the future of India's industrial policy.

# THE ORIGIN OF "ROHR" AT DIDWANA

By H. B. DUNNICLIFF, C.I.E.

IN the June issue of *Current Science*, Dr. E. Spencer[1] has given an explanation of the formation at Didwana of the beds of thenardite or crystalline anhydrous sodium sulphate, locally known as 'rohr', which he claims to be more in harmony with facts than my thesis based on phase rule considerations which appeared in the January number of this *Journal*.[2]

In my desire to be brief, I omitted from that article much of the laboratory and field experimental evidence, part of which I now submit in support of my contention that the formation of sodium sulphate decahydrate antecedent to the development of thenardite is the normal sequence of events in the pans during that portion of the season when night and morning temperatures and the concentration of the brine in the pans make the hydrated salt alone or mixed with sodium chloride, the only possible solid phase according to accepted physical laws.

The manufacturing season commences about the middle of February, the first crop of salt being collected three or four months later. The season normally finishes at the end of April by which time about three lakh maunds of salt would have been harvested. If, however, the demand is great, as in 1942 and 1943 (4·24 lakh and 3·75 lakh maunds respectively), the season is extended to the end of May and even well into June, but the salt harvested in the latter months is discoloured through contamination with dust and contains increasingly high percentages of sodium sulphate.

In certain circumstances, the temperature conditions necessary for the separation of Glauber's salt may persist until about the middle of March.

Table I giving the maximum and minimum atmospheric temperatures at Didwana for the first three months of 1942, studied in conjunction with Table II (p. 296), supports this view. The brine would not attain these minima, the difference between atmospheric and brine temperature would vary with prevailing climatic conditions, the brine temperature being consistently higher than that of the (minimum) atmospheric temperature. The difference of 15° F. between pan and atmospheric minimum temperatures was observed in Saha's experimental eliminator pans (Ref. [2], pp. 9 and 10) in which the layer of brine was far deeper (up to 10 inches) than the shallow layers of brine (1½-2 inches) used by the deswals. This led to a greater retention of heat in Saha's field experiments than in the normal process of salt manufacture in which a difference of not more than + 10° F. might be expected.

Dr. Spencer's laboratory observations and conclusions have made a valuable contribution to this important subject but his experiments have not been conducted under conditions comparable with those which obtain at the salt source.

Thus, the evaporations have proceeded at an approximately uniform temperature of 90° F., which happened to be the temperature in the laboratory where the work was carried out, while, in the field, the crux of the immediate issue is not the concentration of the brine in the pans, but the difference between the relatively high temperature at which the unsaturated brine is fed into the pans, and the much lower supervening night and early morning temperatures before there has been any appreciable evaporation.

Even when some daytime evaporation takes place, fresh crystallisation occurs during the following night in the early part of the season, the deposit of Glauber's salt (which subsequently decomposes into the anhydrous sulphate) accumulating with each addition of brine.

The arguments on page 177, paras 3 and 4, and page 178, paras 1 and 2 of Dr. Spencer's

TABLE I

*Maximum and Minimum Temperatures at Didwana (° F.)*

| | January 1942 | | February 1942 | | March 1942 | |
|---|---|---|---|---|---|---|
| | MAX. | MIN. | MAX. | MIN. | MAX. | MIN. |
| 1 | 79 | 35 | 82 | 43 | 90 | 55 |
| 2 | 81 | 37 | 82 | 39 | 88 | 48 |
| 3 | 82 | 36 | 77 | 36 | 90 | 54 |
| 4 | 70 | 30 | 77 | 32 | 84 | 50 |
| 5 | 79 | 43 | 75 | 30 | 91 | 55 |
| 6 | 82 | 41 | 79 | 34 | 88 | 54 |
| 7 | 82 | 48 | 81 | 34 | 77 | 47 |
| 8 | 84 | 54 | 86 | 43 | 79 | 48 |
| 9 | 70 | 23 | 88 | 40 | 93 | 51 |
| 10 | 64 | 22 | 75 | 48 | 95 | 51 |
| 11 | 57 | 23 | 88 | 50 | 95 | 51 |
| 12 | 68 | 24 | 89 | 52 | 97 | 55 |
| 13 | 66 | 34 | 75 | 37 | 92 | 52 |
| 14 | 68 | 32 | 79 | 35 | 93 | 51 |
| 15 | 72 | 41 | 80 | 36 | 97 | 51 |
| 16 | 73 | 36 | 80 | 35 | 102 | 51 |
| 17 | 70 | 37 | 87 | 45 | 97 | 55 |
| 18 | 70 | 37 | 74 | 34 | 98 | 59 |
| 19 | 65 | 32 | 74 | 32 | 104 | 59 |
| 20 | 65 | 32 | 86 | 50 | 86 | 57 |
| 21 | 70 | 34 | 86 | 57 | 91 | 55 |
| 22 | 76 | 34 | 88 | 50 | 91 | 55 |
| 23 | 77 | 32 | 86 | 52 | 102 | 59 |
| 24 | 81 | 39 | 89 | 50 | 106 | 59 |
| 25 | 73 | 34 | 91 | 55 | 102 | 66 |
| 26 | 73 | 35 | 90 | 50 | 106 | 70 |
| 27 | 77 | 43 | 80 | 55 | 102 | 57 |
| 28 | 75 | 38 | 68 | 54 | 95 | 50 |
| 29 | 74 | 41 | | | — | — |
| 30 | 81 | 45 | | | 99 | 55 |
| 31 | 81 | 45 | | | 102 | 57 |

November 19–30, 1941 : Max. 93° F.; Min. 41° F. (Max. Min. = 47° F.).

December 1–31, 1941 : Max. 88° F.; Min. 35° F. (Max Min. = 48° F.).

paper[1] do not appear to me to be relevant and the discussion of the phenomenon in terms of the solutions at the sodium sulphate-sodium chloride transition points is not applicable to the general proposition. Quantities of phases in conjugate solid and liquid phases formed by chilling unsaturated solutions to temperatures at which they are supersaturated cannot be calculated by the simple subtraction of percentages, for this purpose, the appropriate isothermal or polythermal diagrams are necessary.

Dr. Spencer has, however, presented a scientific and highly probable explanation of the unexpectedly low percentage of sodium chloride in the 'rohr' when conditions are such that the two anhydrous salts must separate simultaneously. This is based on the difference between the densities of the crystals of NaCl and $Na_2SO_4$, assisted by the strong tendency of the NaCl to form box-like floating crystals. We have discussed this problem and I am in complete accord with Dr. Spencer's views where the anhydrous sulphate is directly deposited, but I shall show that Glauber's salt, even if co-precipitated with some sodium chloride as is normally the case, will ultimately yield the anhydrous sulphate relatively free from sodium chloride.

Table II gives the solubility relationships[3] for the system NaCl-$Na_2SO_4$-$H_2O$ at important points.

$Na_2SO_4$) at which, from a solution also containing 13·6 per cent. NaCl, a mixture of $Na_2SO_4$, 10 $H_2O$ and $Na_2SO_4$ is deposited. Between 63·5°. and 77° F., however (*vide* Table II), there would be solutions having lower concentrations of $Na_2SO_4$ from which the mixture of $Na_2SO_4$ and $Na_2SO_4$, 10 $H_2O$ would separate. For a detailed study of this the full polythermal diagrams and data would be necessary.

When Glauber's salt separates from 'kul' brine containing 18 per cent. NaCl and 6 per cent. $Na_2SO_4$ at about 27° C. by simply cooling it to 10° C., the residual brine could only contain about 3·1 per cent. of $Na_2SO_4$ in presence of 18 per cent. NaCl, the balance of the $Na_2SO_4$ (2·9 per cent.) having crystallised out as $Na_2SO_4$, 10 $H_2O$. The removal of the water as water of crystallisation automatically increases the concentration of the NaCl so that, the curve being steep, the transition point may be reached quickly and some NaCl separate with the $Na_2SO_4$, 10 $H_2O$. This effect would be intensified at 5° C. (41° F.) (*vide* Table III) and result in the separation of a still greater proportion of Glauber's salt. In my former paper,[2] the relationship is explained with the assistance of a diagram, but an approximate calculation will help the picture. Assuming that (unsaturated) 'kul' brine at 27° C. containing NaCl = 18 per cent.; $Na_2SO_4$ = 6 per cent., and $H_2O$ = 76 per cent., is cooled to 10° C., the

TABLE II

*Percent. in 100 Grams of Solution*

| 0°C. (32° F.) | | 10°C. (50° F.) | | 17·5° C. (63·5° F.) | | 25° C. (77° F.) | | Solid Phase |
|---|---|---|---|---|---|---|---|---|
| NaCl | $Na_2SO_4$ | NaCl | $Na_2SO_4$ | NaCl | $Na_2SO_4$ | NaCl | $Na_2SO_4$ | |
| 0·00 | 4·65 | 0·00 | 8·38 | 0·00 | 14·10 | 0·00 | 21·90 | |
| | | 3·87 | 5·80 (*a*) | | | | | |
| | | 8·39 | 4·16 | 8·12 | 8·51 | | | $Na_2SO_4$, 10 $H_2O$ |
| 10·70 | 1·50 | 13·8 | 3·37 | | | | | |
| | | 17·35 | 3·16 (*b*) | 16·90 | 6·80 | 7·66 | 16·00 | |
| | | 23·27 | 3·57 | | | | | |
| 25·54 | 1·30 | 24·37 | 3·43 (*c*) | 22·30 | 7·31 | 13·53 | 15·42 | $Na_2SO_4$, 10 $H_2O$ *plus* NaCl |
| *Note*: Anhydrous sodium sulphate cannot form below 17·9° C. (64·2° F.) | | | | | | 13·60 | 14·76 | $Na_2SO_4$, 10 $H_2O$ *plus* $Na_2SO_4$ |
| | | | | | | Intermediate Concentrations | | $Na_2SO_4$ |
| | | | | | | 22·70 | 8·06 | $Na_2SO_4$ *plus* NaCl |

From these figures it will be observed that:

(i) A solution containing only, for example, (*a*) 9·67 per cent., or (*b*) 20·5 per cent. total salts can be in equilibrium with Glauber's salt.

(ii) A solution containing 18 per cent. NaCl and 6 per cent. $Na_2SO_4$ at 25° C. (77° F.) is unsaturated but, on concentration, the solid phase which would separate would be $Na_2SO_4$ or $Na_2SO_4$ *plus* NaCl. Glauber's salt can only be a solid phase at 25° C. at high concentrations of $Na_2SO_4$ (minimum 14·76 per cent.

residual brine could only contain about 3·1 per cent. of $Na_2SO_4$ in the presence of 18 per cent. NaCl (*vide* Table II and Ref. 3), the balance of the $Na_2SO_4$ (2·9 per cent.) having crystallised out as $Na_2SO_4$, 10 $H_2O$, simultaneously removing $2·9 \times 1·27 = 3·7$ parts of $H_2O$ as water of crystallisation. In nature, supersaturation is not likely to occur. The residual brine should thus contain 18·0 parts NaCl 3·1 parts $Na_2SO_4$ and $(76 - 3·7) = 72·3$ parts $H_2O$ or, calculated as percentages, NaCl = 19·3 per cent.; $Na_2SO_4$ = 3·3 per cent.; $H_2O$ = 77·4

per cent. As a matter of fact, the solution is supersaturated with respect to $Na_2SO_4$, 10 $H_2O$ and the result will be that some more $Na_2SO_4$, 10 $H_2O$ will deposit and the point at which some NaCl also separates be attained. Accurate calculation by this method is not possible but about 50 per cent. of the sodium sulphate comes out as $Na_2SO_4$, 10 $H_2O$.

In the field, when the temperature in the shallow pans rises above the $Na_2SO_4$, 10 $H_2O$-$Na_2SO_4$ transition point, the decahydrate loses water and changes into $Na_2SO_4$. The water mixes with the liquid phase taking the NaCl (and some $Na_2SO_4$) with it, a process which is assisted by the stirring. Hence, even if originally contaminated with NaCl, the sodium sulphate deposited will be left behind considerably purified and the resultant composition of the liquid phase need have no relevance to the composition of the liquid phase at the NaCl-$Na_2SO_4$, 10 $H_2O$ transition point.[6]

In fact, the manufacture of high grade anhydrous sodium sulphate from Glauber's salt by adding solid common salt and heating to 20-22° C. by low pressure steam, is a commercial process.[4]

Thus, at Didwana, the water crystallised out is returned to the brine and becomes mixed with it. During the cold period, after some concentration by wind and rise of temperature, a further moiety of Glauber's salt can be deposited the following night and similarly for successive days so long as temperature and concentration conditions make $Na_2SO_4$, 10 $H_2O$ the only solid phase (*vide* Seidell[3]). The sodium sulphate will naturally be mixed with the sodium chloride crystallising out as stated by Dr. Spencer and, owing to the vertical direction of the curve, the transition point will be quickly attained after the bulk of the $Na_2SO_4$ 10 $H_2O$ has separated.

In an actual field experiment in which masses of the decahydrate separated overnight, the unwashed but filter-paper-dried Glauber's salt analysed as follows:

$Na_2SO_4$, 10 $H_2O$ = 97·63 per cent.;
NaCl = 2·20 per cent.;
$Na_2CO_3$ = 0·07 per cent.; and
$NaHCO_3$ = 0·08 per cent.

At the daytime higher temperatures, when the $Na_2SO_4$, 10 $H_2O$ passes into $Na_2SO_4$, the water in the Glauber's salt would make a 4 per cent. solution with the sodium chloride present and some sodium sulphate would also naturally dissolve into the liquid phase to the equilibrium point.

### Laboratory Experiments

In the laboratory experiments (Ref. [2], p. 9), the results set forth in Table III which has been condensed as far as possible by giving only the $Na_2SO_4$ and NaCl percentages were obtained.

Raw Didwana brine (Ref. [2], Table III, Samples 2, 3, 5 and 6) was kept in a refrigerator for sufficient time for equilibrium to be established, so far as was possible without stirring, at a temperature of about 40-42° F. (5° C.). Crystals of $Na_2SO_4$, 10 $H_2O$, contaminated with NaCl, separated. Attention is drawn to the similarity of composition in Samples 2, 3 and 5, Table III (2), which corresponds to 6·35 per cent. NaCl on the crystal sulphate, $Na_2SO_4$, 10 $H_2O$. This shows that the $Na_2SO_4$, 10 $H_2O$-NaCl transition point was attained after the early separation of $Na_2SO_4$, 10 $H_2O$ was completed.

Table III

(1) *Raw Brine*

| Sample No. | 2 | 3 | 5 | 6 |
|---|---|---|---|---|
| NaCl | 19·53% | 18·49% | 16·05% | 16·97% |
| $Na_2SO_4$ | 5·95% | 6·56% | 7·64% | 4·68% |
| NaCl: $Na_2SO_4$ | 3·28 : 1 | 2·8° : 1 | 2·10 : 1 | 3·63 : 1 |

Average about 3 : 1 (NaCl = 18%; $Na_2SO_4$ = 6%)

(2) *Glauber's Salt Deposit Calculated on a Dry Basis*

| | % | % | % | — |
|---|---|---|---|---|
| NaCl | 13·11 | 13·15 | 13·15 | — |
| $Na_2SO_4$ | 85·09 | 85·45 | 85·78 | — |

Average proportions, $Na_2SO_4$ : NaCl = 6·5 : 1.
In terms of actual components, this gives
$Na_2SO_4$, 10 $H_2O$ = 93·7 per cent.;
NaCl = 6·3 per cent.,
and the percentage composition of the crystalline mixture becomes
$Na_2SO_4$, 10 $H_2O$ = 91·6 per cent.;
$Na_2SO_4$, 10 $H_2O$ + NaCl = 8·4 per cent.

(3) *Resultant Mother-Liquor or Purified Brine*

| | % | % | % | % |
|---|---|---|---|---|
| NaCl | 21·44 | 21·44 | 18·14 | 22·90 |
| $Na_2SO_4$ | 1·98 | 1·45 | 1·88 | 1·75 |

(4) *Purity of Salt Crystallised from Mother-Liquor*

| | % | % | % | % |
|---|---|---|---|---|
| NaCl | 98·42 | 97·68 | 98·51 | 97·05 |
| $Na_2SO_4$ | 0·92 | 1·49 | 0·86 | 1·96 |

These figures for 5° C., seldom attained in nature, indicate a much higher order of elimination of sulphate than those quoted above for 10° C. (50° F.). This and the variable composition of the mother-liquor is due to absence of stirring and to variations of temperature which probably often fell below 5° C., as correct thermostatic conditions could not be maintained because the refrigerator had to be used for general laboratory purposes. Even with this high percentage of sodium chloride, the water in the Glauber's salt is sufficient to give about 12 per cent. sodium chloride solution on change of phase.

I hope that these details of experiments, which were not carried out under ideal labo-

ratory conditions but with an attempted approximation to natural conditions, will explain the possibility of the removal of half or more of the sulphate as decahydrate in a single stage under suitable temperature conditions which in fact exist for an appreciable part of the normal manufacturing season at Didwana. As explained above, the water of crystallisation returns to the liquid phase with some sodium sulphate but a second deposition of crystals takes place during the next cool night and so on.

### Conclusions

I have discussed this problem with Dr. Spencer and we are agreed that the deposits are due to the two processes operating one after the other.

From mid-February to possibly about the middle of March, Glauber's salt separates and is subsequently dehydrated and deposited on the previous layers of thenardite.

This is succeeded by a short intermediate period when the hydrated and anhydrous sodium sulphate crystallise out together. For the rest (and greater part) of the season, the process described by Dr. Spencer[1] takes place. This is followed by the conversion of the finer deposits formed in either of the two ways into the massive form of natural crystalline sodium sulphate, thenardite.

Variations in the percentage of sodium chloride in the deposits may be due (*i*) to the extension of the season as in 1923 (7·49 lakh maunds); 1925 (4·02 lakh maunds); 1931 (5·34 lakh maunds), and 1932 (4·55 lakh maunds) when the demand for salt was high, (ii) to the incomplete purging from sodium chloride as described by myself, or (iii) to abnormal disturbances causing more sodium chloride than usual to separate in the process described by Dr. Spencer.

It is unfortunate that my proposal for a continuous scientific observation of the salt and 'rohr' production at Didwana was not accepted in 1941, as the results would have provided full data for the solution of this interesting phenomenon. Dr. Spencer and I are of opinion that detailed field work extending over a complete season, from November to June, including a full examination of Saha's eliminator pan proposals, is highly desirable.

### Sambhar Lake Bitterns

On page 179 of his article (*loc. cit.*), Dr. Spencer makes certain suggestions regarding the separation of the components of Sambhar Lake bitterns. Elsewhere[5,6] I have described in some detail the immense saline deposits in the East Lake Bitterns Area and have also attempted to re-construct the manner in which their stratified formation has been developed. Proposals have also been made for their commercial exploitation.

Although the $NaCl : Na_2SO_4$ ratio in Sambhar kyar bitterns resembles the corresponding average ratio in Didwana brines, it is actually rather higher and the concentration of the carbonates of sodium (about 4 per cent. as $Na_2CO_3$) is too high to be disregarded as has been possible when discussing the crystallisation of Didwana 'kul' brines in which the carbonate percentage as $Na_2CO_3$ is usually of the order of 1 per cent. or under. Algal and bacterial impurities,[8] not encountered at Didwana, also complicate the problem at Sambhar

When allowed to crystallise out in kyars reserved for the purpose, the bitterns from the manufacture of kyar salt[7] deposit "manufactured bitterns salt" of varied composition but averaging very roughly: NaCl = 62 per cent.; $Na_2SO_4$ = 22 per cent.; $Na_2CO_3$ = 7-8 per cent. and $NaHCO_3$ up to 3·8 per cent.[6] This salt is now being produced in commercial quantities for industrial purposes.

Characteristics of the Didwana brines are, therefore, relatively low carbonate content, absence of double salt formation and the non-interference of organic matter.

Examination of the bitterns of salt deposits which have accumulated in the East Lake Area at Sambhar over a period of nearly forty years, involves the interpretation of a five-component system:

$$NaCl\text{-}Na_2SO_4\text{-}Na_2CO_3\text{-}NaHCO_3\text{-}H_2O$$

(in which $CO_2$ is also present) under peculiar and annually varying conditions. The progressive crystallisation and partial recrystallisation of the bitterns has yielded vast quantities of a considerable range of sodium salts together with sodium chloride. These include sodium bicarbonate, $NaHCO_3$; sodium sesquicarbonate or crystal carbonate, $Na_2CO_3$, $NaHCO_3$, 2 $H_2O$; burkeite, $Na_2CO_3$, 2 $Na_2SO_4$ (and possibly sesquiburkeite, 2 $Na_2CO_3$, 3 $Na_2SO_4$) (*vide* Ref.,[6] layers B, C and E). In 1939, careful investigation of these stratified deposits led to the discovery near the surface of a 3-4" layer of crystal salt of excellent quality. From this stratum,[7] 13·9 lakh maunds of alimentary salt were extracted in the 1939-40 season while, in the following year, the early showers of the monsoon provided surface "washings" of concentrated brine from which 39·43 lakh maunds of kyar salt were crystallised out.

1. Spencer, E., *Curr. Sci.*, 1943, **12**, 176. 2. Dunnicliff, H. B., *Curr. Sci.*, 1943, **12**, 7. 3. Seidell, A., *Solubilities of Inorganic and Metal Organic Compounds*, D. Von Nostrand Inc., 1940, **1**, 1234–5 and *International Critical Tables*, 1928, **4**, 287. 4. Roberston, G. R., *J. Ind. Eng. Chem.*, 1942, **34**, 133. 5. Dunnicliff, H. B., *Rec. Geol. Surv. Ind.* (in the Press). 6. Auden, J. B., Gupta, B. C., Roy, P. C. and Hussain M., *Rec. Geol. Surv. Ind.*, 1942, **77**, 34. 7. Dunnicliff, H. B., *J. Sci. Indst. Res.*, 1943, **1**, No. 4, p. 270. 8. Dunnicliff, H. B., and Padwick, *J. Ind. Chem. Soc., Indust. and News Edn.*, 1943, **6**, 4.

## PROF. A. V. HILL, F.R.S.

WE wish to extend a hearty welcome to Prof. A. V. Hill, F.R.S., who has just arrived in Delhi at the invitation of the Government of India. He is to study on the spot the achievements of science and industry in India and to explore avenues of closer collaboration between Indian scientific workers and those of the United Nations.

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## CENTRAL HIMALAYAN GEOLOGY

In a recent paper[1] Professor K. P. Rode has discussed the stratigraphical and tectonic successions of the Himalayan rocks of Sirmur State, and has extended his conclusions to other areas not studied by him. These conclusions are in complete disagreement with published and unpublished work of W. D. West and myself. Only a few of Rode's assumptions can be discussed within the limits of a short letter to *Current Science.*

(1) Rode states that the correlation of the Bansa limestone with the Krol limestones is "irresistible", and that the true Krol Nappe is represented by the outcrop of the Bansa limestone. In view of the absence of fossils in these rocks, correlation of necessity depends on a balance of evidence from lithology, chemical composition, thickness of stages, metamorphism and structural position. The analyses of certain Himalayan limestones and dolomites are given in the table below:—

| | Mandhali | Bansa | Blaini | Lower Krol | Upper Krol | Upper Krol Marble, near Mussoorie |
|---|---|---|---|---|---|---|
| Number of analyses | 3 | 7 | 2 | 7 | 8 | 12 |
| $SiO_2$ | 12·80 | 27·84 | 6·20 | 27·64 | 0·18 | 0·14 |
| $Al_2O_3+Fe_2O_3$ | 3·53 | 3·47 | 4·48 | 12·90 | 1·24 | 0·15 |
| CaO | 45·79 | 37·29 | 28·02 | 23·57 | 33·05 | 55·14 |
| MgO | 1·01 | 0·71 | 18·48 | 5·84 | 18·45 | 0·38 |
| $CaCO_3$ calculated from CaO | 81·8 | 66·6 | 50·0 | 42·1 | 59·0 | 98·47 |
| $CaO/SiO_2$ ratio | 3·58 | 1·34 | 4·52 | 0·85 | 183 5 | 394 |
| CaO/MgO ratio | 45·3 | 52·5 | 1·52 | 4·04 | 1·79 | 145 |
| Lithology | slaty limestone and calc slate | sandy limestone and calc quartzite | pink hard siliceous dolomite | shaly limestone and calc shale | dark and pale dolomite | white marble |
| Thickness in feet of bands or stages | 50–300 | 50–300 | 10–30 | 300–700 | 2,500–3,000 | 15–100 |
| | | | | With Krol Red Shales and dolomites the thickness of the Krol series may be taken as 3,500—4,000 feet. | | |

The profound differences between the Bansa and the various Krol carbonate rocks is clear from this table, and is sufficient to refute Rode's correlation on the only evidence at present available. Whatever the age relation-

ship of the Krol and Bansa rocks may ultimately prove to be, in lithological facies and structural positions they are entirely different.[2] Moreover, Rode's idea that the Bansa limestone lies in the core of a fold (his Fig. 1) is almost certainly untenable, because this limestone continues below the Chandpur series and crops out on the south side of the Tons syncline, where it dips northwards.

(2) Rode assumes that the Blaini boulder bed is a mid-tertiary tectonic breccia or conglomerate devoid of stratigraphical significance. He omits, however, the Blaini from his sections, in the places where it should have been shown, as if it did not exist, and fails to indicate the thrust planes which he postulates from its supposed nature. The Blaini boulder beds (over wide areas there are two boulder beds, separated by banded slates) and Infra Krol slates have been traced for 120 miles, constantly overlain along the Krol belt by Krol rocks. They can be followed, for example, for seventy miles round the Mussoorie basin (one of five basins of the Blaini-Krol-Tal succession east of longitude 77° 30') in a very definite stratigraphical position. Rode is further mistaken in supposing that the occasional boulders of Dagshai-like sandstone found in the Blaini must be of Tertiary age. Such sandstones are found in the Simla slates and the Nagthat series, both almost unquestionably pre-Mesozoic formations.

(3) Rode regards the Lower Tal shales as inverted Infra Krol, and divorces them by thrust contact from the Upper Tal quartzites which he considers to be Jutogh. Our two successions may be placed side by side:—

| | RODE | AUDEN |
|---|---|---|
| *Top* | Jutogh Nappe | Schists and phyllites of the Garhwal nappe, with intruded Lansdowne granite |
| | | *thrust* |
| | | Nummulitic |
| | | Tal fossiliferous limestone |
| | | Upper Tal quartzites (*uninverted*) |
| | *thrust* | *lithological gradation* |
| *Bottom* | Infra Krol (*inverted*) | Lower Tal shales |

In uniting so many different units in his Jutogh nappe, Rode has ignored the following facts:—

(*a*) The Nummulitics between the schistose rocks and the Upper Tal:[4] (*b*) the Upper Tal fossiliferous limestone, the fossils of which are not, unfortunately, of diagnostic value: (*c*) the uninverted nature of the Upper Tal quartzites, as abundantly proved by the disposition of the current bedding:[5] (*d*) the lithological gradation between the Tal shales and quartzites, which makes them with virtual certainty one series:[6] (*e*) the meso-grade metamorphism of the Jutogh series as contrasted with the unmetamorphosed (locally epi-metamorphosed) nature of the Tal quartzites: (*f*) lithological differences between the Tal and Jutogh quartzites.

(4) Rode believes that the Chor, Dudatoli, Lansdowne and Almora granites have exerted no thermal metamorphism on the schists in which they occur, but are thrust klippen tectonically divorced from the schists. W. D. West has found that the Chor granite sinks northwards under Jutogh schists, and has in fact been intruded along the centre of a syncline of the Jutogh series. The Dudatoli and Almora granites occur in the form of lenticular sills embedded within the schists. Moreover, the Chor, Dudatoli and Lansdowne granites have all been found to have caused a superposition of thermal metamorphism upon the more general regional metamorphism.[7] The interpretation which West and I put upon the field evidence is that these granites were intruded into the contiguous pelitic sediments before the thrust movements which later brought both granite and host into their present tectonic positions. Rode's "Central Granite Thrust" does not exist, because, after crossing the great tectonic window which the writer has traced from Banchangaon (30° 54':78° 14') south-eastwards to Almora, and by Heim and Gansser from Dudatoli to near the Nepalese frontier (their Calc Zone of Tejam),[8] one returns to a composite series of ortho-gneisses, paragneisses and schists, of the south face of the main Himalayan range, which is homologous with the rocks of the Dudatoli-Almora zone. The same feature is found north of the Larji 31° 43':77° 13') tectonic window towards the Rohtang pass. The massive granite around Gangotri is also clearly intrusive, lying capped by roof-pendants of metamorphosed Simla Slates, into which it has locally sent up a network of pegmatite offshoots in part responsible for the presence of garnet, staurolite and kyanite.

The verification of these points is in the field, for the most part in areas beyond those visited by Rode, but notwithstanding described by him.

Geological Survey of India,
Calcutta, J. B. AUDEN.
*September* 19, 1943.

1. *Proc. Ind. Acad. Sci.*, 1943, **17**, 157. 2. *Rec., Geol. Surv. Ind.*, 1942, **77**, Prof. Pap. 2, 7. 3. *Op. cit.*, 1937, **71**, 415. 4. *Ibid.*, Plate 37, Section 2. 5. *Ibid.*, 1933, **67**, 394; 1937, **71**, 417. 6. *Ibid.*, 1933, **67**, 394. 7. *Mem. Geol. Surv. Ind.*, 1928, **53**, 60–72; *Rec. Geol. Surv. Ind.*, 1887, **20**, 136, and maps 40, 143. 8. *Denkschr. d. Schweiz. Naturforsch. Ges.*, 1939, **73**, Abh. 1.

## CHEMICAL EXAMINATION OF *OCIMUM CANUM* SIMS.

*Ocimum canum* Sims. belongs to the natural order Labiatæ and grows abundantly throughout Gujarat. Its leaves are used in skin diseases,[1] and seeds, locally known as "Tukmaria", are said to be tonic and very useful in gonorrhœa. With a view to isolate active principles from them, the investigation of the seeds, leaves, etc., of this plant has been undertaken.

The powdered seeds were successively extracted with ether, carbon tetrachloride,

alcohol, etc. The ether and carbon tetrachloride extracts yielded a yellow fatty oil (about 10 per cent). The following are the analytical constants for the oil.

Specific gravity at 30°—0·9206.
Refractive index at 40°—1·4707.
Acid value—72·15.
Saponification value—194·5.
Iodine value (Hanus)—179·8.
Unsaponifiable matter (per cent.)—1·25.
Hehner number—88·14.
Reichert-Meissl value—0·6.
Polenske value—0·3.
Acetyl value—32·1.

The chemical examination of the oil and other extracts of the seeds is in progress.

An essential oil obtained in 0·1 per cent. yield from the fresh leaves is also being investigated.

Central Excise Laboratory, C. R. MEHTA.
The Technological Institute, T. P. MEHTA.
Baroda,
*September* 23, 1943.

1. Watt's *Dictionary of the Economic Products of India* **5**, 442; Chopra's *Indigenous Drugs of India*, 511.

## *ENTAMOEBIC* INFECTION IN CERTAIN CILIATES

*Entamœba*, which is a parasite of several Metazoa, has recently been reported to parasitize certain Protozoa, *e.g.*, *Protoopalina*, *Zelleriella*, *Cepedea* and *Opalina* (*vide* Stabler, 1933; Carini and Reichenow, 1935; Stabler and Chen, 1936; etc.). This preliminary note is the first record of entamœbic infection from India having been availed in certain ciliates, *e.g.*, *Opalina japonica*, *Opalina lata*, *Opalina* sp., *Cepedea longa* *Cepedea longa hispanica*, *Cepedea* sp. (Fig. 1),

FIG. 1.—A portion of *Cepedea* sp. showing entamœbæ (♦). × 1000 *cir.*

*Nyctotherus cordiformis*, and *Nyctotherus* sp. found in *Rana limnocharis* Wiegm, *R. tigrina* Daud, *Bufo himalayanus* Bouleng., and *B. melanostictus* Schneid. Moreover, certain opalinids, *Opalina* spp., and *Cepedea* sp. collected from *Varanus monitor* have also been found to be hyper-parasitized by entamœbæ.

*In vivo* entamœbæ appear as refractile bodies within the opalinid ciliates, but are not so conspicuous within the bodies of the Nyctotheri. The presence of entamœbæ does not appear to affect the normal vital activities of the ciliates, except in acute infections when the ciliates become impoverished.

In fixed and stained preparations the parasites appear morphologically identical with *Entamœba ranarum*, except that they are smaller in size (trophozoites 4·0 μ–16·9 μ; cysts 6·6 μ–12·4 μ). The cysts are invariably uninucleate; glycogen vacuoles and chromatoids also occur within them. The nuclei of the trophozoites and those of the cysts are of the "histolytica-type".

It may be that the parasites become incorporated within the bodies of the Nyctotheri *per os*, but in the astomatous opalinid ciliates the entrance of the parasites would be possible only by direct penetration (Fig. 2).

FIG. 2.—A portion of *Opalina* sp. showing entrance of the parasite (♦). × 833·33 *cir.*

Certain opalinid cysts collected from the amphibians and the lizard were found to contain entamœbæ, but these parasites were never detected in the cysts of the Nyctotheri. Such opalinid cysts, according to Stabler and Chen, constitute an important method of transmission of the entamœbæ from adult amphibians to their tadpoles through the medium of water. But it is difficult to account for the transmission of the opalinid cysts in *Varanus*, which lays eggs on land and has no tadpole stage at all.

Walker (1909) has described "sporulation" in certain ciliates, *e.g.*, *Nyctotherus multisporiferus*, *N. parvus*, *Balantidium falciformis* and *B. coli*, but Sassuchin (1928) doubts this and believes that Walker mistook the fungus, *Sphærita*, (which Sassuchin found in *Nyctotherus ovalis*), for the "spores" of the ciliates. The present author, however, believes that the objects which Walker called "spores" were really entamœbæ. For instance, the so-called "spores" seen in his Figs. 1, 2, 3 and 4 on Pl. 14, and

Fig. 8 on Pl. 15, resemble the parasites seen in the photomicrograph (Fig. 3) accompanying

FIG. 3.—*Nyctotherus* sp. showing entamœbæ (*p*) × 333·33.

this paper. Walker's Fig. 5 on Pl. 15, seems to represent not enlarged "spores", but deeply stained entamœbæ invaded by certain micrococci and the so-called "remnant of the broken down sporocyst" enclosing these "spores" is, in all probability, an artefact formed by aggregation of bacteria and other extraneous matter.

Zoology Department,
University of Lucknow,
Lucknow, P. L. MISRA.
*August* 28, 1943.

1. Chen, T. T., and Stabler, R. M., *Biol. Bull.*, 1936, **70**, 72. 2. Sassuchin, D. N., *Arch. f. Protistenk.*, 1928, **164**, 61. 3. Stabler, R. M., and Chen, T. T., *Biol. Bull.*, 1936, **70**, 56. 4. Walker, E. L., *Arch. f. Protistenk.*, 1909, **17**, 297.

## SELACHIAN FAUNA OF BOMBAY WATERS

VERY little concentrated work has been done on the systematics of Indian Elasmobranchs since Dr. Day's time (1889), and complete records of their life-history hardly exist. An opportunity to add to the literature was afforded during investigation of the Selachian fauna occurring along the Bombay coast. Studies spread over a period of two years and a half have established the occurrence of 40 species of sharks, skates and rays as represented in the table below:—

Family—Orectolobidæ: Genus—*Chiloscyllium, C. griseum* Muller and Henle; *Ginglymostoma, G. ferrugineum* (Lesson); *Stegostoma, S. tigrinum* (Forster); *Rhineodon, R. typus* Smith.

Family—Odontaspidæ: Genus—Odontaspis, *O. tricuspidatus* (Day).

Family—Carcharhinidæ: Genus—*Scoliodon, S. sorrakowah* (Cuvier), *S. pallasorrah* (Cuvier), *S. walbeehmi* Bleeker, *S. species*, Sp. Nov.; *Hypoprion, H. macloti* (Muller and Henle); *Carcharinus, C. limbatus* (Muller and Henle), *C. melanopterus* (Quoy and Gaimard), *C. bleekeri* Duméril, *C. menisorrah* (Muller and Henle), *C. species*, Sp. Nov.; *Galeocerdo, G. tigrinus* Muller and Henle; *Hemigaleus, H. balfouri* Day; *Eugaleus, E. species*, Sp. Nov.; *Galeorhinnus, G. musteleus* (Linne).

Family—Sphyrnidæ: Genus—*Sphyrna, S. blochii* (Cuvier), *S. zygæna* (Linné).

Family—Rhinobatidæ: Genus—*Rhynchobatus, R. djiddensis* (Forskal).

Family—Pristidæ: Genus—*Pristis, P. cuspidatus* Latham, *P. perrotteti* Muller and Henle.

Family—Trygonidæ: Genus—*Trygon, T. uarnak* (Forskal), *T. variegatus* Annandale, *T. alcockii* Annandale, *T. gerradii* Gray, *T. bleekeri* Blyth, *T. walga* Muller and Henle, *T. sephen* (Forskal), *T. zugei* Muller and Henle; *Pteroplatea, P. pœcilura* (Shaw).

Family—Myliobatidæ: Genus—*Ætomylæus, A. maculatus* (Gray and Hardwicke); *Ætobatus, A. flagellum* (Schneider); *Rhinoptera, R. javanica* Muller and Henle.

Family—Mobulidæ: Genus—*Mobula, M. eregoodootenkee* (Cuvier), *M. mobular* (Bonnaterre).

Family—Torpedinidæ: Genus—*Narcacion, N. species* Sp. Nov.; *Narcine, N. timlei* Bloch and Schneider.

A glance at the above list shows that four species are new and these forms as well as the species *Mobula mobular* are recorded for the first time from Indian waters. With the exception of five species, namely, *Ginglymostoma ferrugineum, Stegostoma tigrinum, Rhineodon, typus, Odontaspis tricuspidatus* and *Narcacion* sp., the rest may be said to be fairly common along the Bombay coast, where they figure regularly in the catches of the fishermen.

Fisheries Section,
Department of Industries,
Bombay. S. B. SETNA.
*August* 10, 1943.

## SOME FACTORS ASSOCIATED WITH FLORAL ABNORMALITIES IN CALENDULA

IN some of the pots of Calendula, it was observed that even after the cessation of flowering and subsequent formation of seeds, small flower buds sprang up from the same receptacle which later showed normal flowering and seed setting. The number of such secondary capitula may be anything from 1 to 10, the largest up till now noticed. The occurrence is more common in the orange-yellow variety than the pure yellow one. Two kinds of such flowering were noticed. In one case, the secondary capitula came out from underneath the receptacle in a way resembling the very common occurrence in daisy (*Bellis perennis*) and in the second case, they came out from the top middle portions of the receptacle. The second type were more common.

Seeds from the original and the secondary capitula were collected separately and it was observed that the seeds from the original receptacle germinated freely, flowered and set seeds. The seeds from the secondary receptacles failed to germinate.

In ordinary flower-beds, the occurrence is usually 1 or 2 per 100 capitula. But recently some Calendula beds were noticed where the frequency counted at different periods appeared to be about 40 per 100. This observation led to the suspicion that soil conditions might have had something to do with supply of mineral matter to the soil and hence double flower formation. Analysis of the representative soil samples from such beds showed no remarkable difference in chemical composition from soils from ordinary beds. Only known difference was in watering, which was exceedingly irregular and scanty in beds where the frequency of abnormal flowering was high.

It is generally considered,[1] that abnormalities in flower do not occur, as we generally think, according to freaks of nature but due to definite effects of abnormal climatic conditions, or conditions of nourishment. It is also known[2] that lack of adequate moisture tends to develop reproductive portions to a greater extent and under the same climatic conditions, less moisture supply in one case means absorption of more mineral salts than in the other.

With this view in mind, an attempt was made to see whether secondary flower formation was associated with the absorption of more mineral matter than in plants bearing no abnormal flower.

Since it was seen that the same plants may have branches both containing abnormal flower formation and also the normal ones it was thought probable that the difference existed only between the branches and not in the original plants and consequently only the branches were cut off and used in analysis.

Three types of branches were studied: (1) The branches just before ordinary flowering, (2) just after complete setting of seeds where there was no subsequent double flowering and (3) just after first seed setting and before the formation of complete secondary buds. Stalks, leaves and the receptacles in a single branch were taken separately. In the receptacle care was taken to remove florets and seeds, leaving the real receptacle. In cases of abnormal flowering, the secondary buds, if any, were removed. Before subjecting to analysis, the plants were washed with distilled water to remove any adhering dust particles. pH, moisture, nitrogen, ash, $P_2O_5$ and $K_2O$ were estimated.

pH values of the plant saps of the abnormal flowering branches did not show any remarkable deviation from the pH values of the other branches. In all the cases, the receptacle was more acid than the stalk or leaf juices.

The results of analysis of the different portions indicate fairly well, the greater absorption of $K_2O$, $P_2O_5$ and mineral matter in general from the soil by the abnormal branch. It may be, therefore, fair to assume that this absorption of extra mineral matter is responsible for further growth. The mineral matter content of the abnormal flowering branch was not at all exhausted as was the case with the normal one. Even after the first flowering and seed setting it maintained the same potentialities as a branch before first flowering. The detailed results are given below:—

Moisture %

| | just before flowering | just after formation of seeds | abnormal flowering |
|---|---|---|---|
| stalk | 90·4 | 85·7 | 82·9 |
| leaves | 80·3 | 79·1 | 63·4 |
| receptacle | 80·5 | 74·1 | 75·0 |
| **Nitrogen %** | | | |
| stalk | 2·64 | 1·32 | 1·39 |
| leaves | 4·14 | 3·48 | 2·43 |
| receptacle | 3·62 | 2·33 | 1·95 |
| **Ash %** | | | |
| stalk | 28·01 | 12·53 | 24·69 |
| leaves | 32·63 | 16·29 | 34·73 |
| receptacle | 16·95 | 9·87 | 24·55 |
| **$P_2O_5$ %** | | | |
| stalk | 1·09 | 0·72 | 0·68 |
| leaves | 0·90 | 0·74 | 0·76 |
| receptacle | 1·31 | 1·01 | 1·27 |
| **$K_2O$ %** | | | |
| stalk | 6·83 | 2·40 | 7·61 |
| leaves | 4·85 | 4·07 | 5·47 |
| receptacle | 4·35 | 3·26 | 5·62 |

It appears possible that the double flowering may be associated with irregular water supply where some plants are made to absorb extra amount of mineral matter under drought conditions, when the concentration of plant food materials is much more than when the soil is normally moist.

My grateful thanks are due to Rao Bahadur B. Viswanath and Dr. B. P. Pal, for many helpful criticisms and valuable suggestions.

Imperial Agricultural Research Institute, New Delhi, *September* 29, 1943. ABHISWAR SEN.

1. Wordsdell, W. C., *The Principles of Plant Teratology*, 1916, **2**, 18–30. 2. Smith, J. W., *Agricultural Meteorology*, 1920, p. 84.

## ABNORMAL CIRCULATION IN THE COMMON INDIAN FROG *RANA TIGRINA* DAUD.

ABNORMALITIES in the circulatory system of Anura are numerous. Those in the common European frog *Rana temporaria* have been reported by Crawshay (1906), Collinge (1915), Flattely (1926), Lloyd (1928), Grove and Newell (1934) and O'Donoghue (1932, 1933, 1935). A number of Indian workers (Ahuja, 921; Bhaduri, 1929 *a* and *b*; Khatib Husain, 1938; Mathur and Sharma, 1938) have described abnormalities in the vascular system in *Rana tigrina*.

I have found the following abnormalities in a female specimen of *Rana tigrina*:—

I. *Venous abnormalities.*—(1) A persistent right posterior cardinal vein joining the innominate vein on the right side and the absence of the post-caval vein. (2) The presence of two dorso-lumbar veins on each side joining the renal portal veins.

II. *Arterial abnormality.*—An additional arterial branch arising from the Carotid arch.

*Venous Abnormalities.*—The absence of the post-caval and the persistence of the right posterior cardinal.

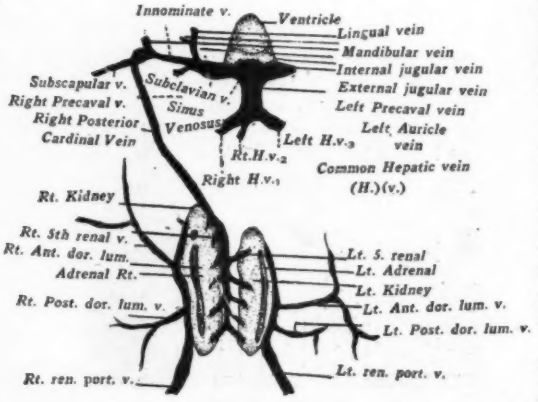
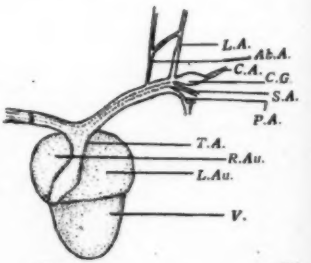



FIG. 1 ×·5

*Rt. Ant. dor. lum.*, Anterior dorso-lumbar vein; *Rt.*, Right; *Lt.*, Left; *Rt. ren. port. v.*, Right renal portal vein; *Rt. Post. dor. lum. v.*, Right posterior dorso-lumbar vein; *Lt. ren. port. v.*, Left renal portal vein.

Fig. 1 illustrates the venous abnormalities. The post-caval is replaced by the persistent right posterior cardinal. The kidneys are dissimilar in size and the renal veins of the right side are more in number than those on the left side correlated with the larger size of the right kidney. The presence of two dorso-lumbar veins is also seen. So far as the veins from the liver are concerned, two hepatic veins arise from the right lobe of the liver while only one arises from the left. All these fuse to form a single hepatic vein which opens directly into the sinus venosus since the post-caval is absent.

*Arterial Abnormality.*—This is interesting since arterial abnormalities occur far less frequently than venous ones. The left Carotid arch gives origin to an abnormal artery before the point of origin of the lingual artery. It gives off two branches, one of which joins the lingual artery while the other supplies certain muscles (Fig. 2).




The ventral view of the heart showing only the left aortic arches.

FIG. 2 ×·75

*Ab.A.*, Abnormal artery; *C.A.*, Carotid artery; *C.G.*, *Carotid Gland*, *L.A.*, Lingual artery; *L.Av.*, Left Auricle, *P.A.*, Pulmocutaneous arch; *S.A.*, Systemic arch; *T.A.*, Truncus arteriosus; *R.Au.*, Right auricle, *V.*, ventricle.

My best thanks are due to my colleagues and also to Principal Dr. K. Krishnamurti for their advice and encouragement.

Department of Zoology, College of Science, Nagpur, *September* 7, 1943. THAKUR S. B. SINGH.

1. Ahuja, H. C., *Proc. Ind. Sci. Congress*, 1921. 2. Bhaduri, J. L., *Proc. Zool. Soc., London*, 1929 *a*. 3. —, *Jour. Dept. Sci., Calcutta*, 1929, *b*, 10. 4. Collinge, W. R., *Jour. Anat. and Physiol.*, 1915. 5. Crawshay, L. R., *Proc. Zool. Soc., London*, 1906. 6. Flattely, F. W., *Nature, London*, 1926. 7. Grove, A. J., and Newell, G. E., *Jour. Anat.*, 1934, 68. 8. Khatib Husain, S. M., *Proc. Ind. Acad. Sci.*, 1938, **7**. 9. Lloyd, J. H., *Proc. Zool. Soc. Lond.*, 1928. 10. Mathur, L. P., and Sharma, M. L., *Proc. Ind. Acad. Sci.*, 1938, **8**. 11. O'Donoghue, C. H., *Trans. Roy. Soc. Edinburgh*, 1932, 57. 12.—, *Anat. Anz.*, 1933, **Bd. 75**. 13. —, *Jour. Anat.*, 1935, 70.

## A NEW VARIETY OF *DROSERA INDICA* LINN. FROM KOLHAPUR (S.M.C.)

IN an intensive study of the flora of Kolhapur (Deccan) three types of the insectivorous plant, *Drosera* are met with. Two of these are the commoner species, *Drosera indica* Linn. and *Drosera Burmanni* Vahl., already described. Cook[1] mentions a few localities from the

Bombay Presidency where these are found naturally, but not Kolhapur. Roxburgh[4] refers to them as natives of Coromandel, Ceylon, etc. Their occurrence, therefore, in Kolhapur is interesting from point of view of their distribution.

*Drosera Burmanni* Vahl. was collected at Radhanagari hills (a place of heavy rainfall) while *Drosera indica* Linn. was found at Katyayani hills (with much less rainfall), in marshy places.

A third variety of *Drosera*, also collected in a marsh near Gokulshirgaon—very near to the city, differs from *Drosera indica* Linn. in possessing red flowers instead of the usual white ones, while it agrees in other characters very closely. It also flowers in September.

This third type appears, therefore, to be a distinct variety of *Drosera indica* Linn., not recorded by Cook.[1] This may not be the same as that referred by I. Pfleiderer[3] and V. Mayuranathan[2] as having "pinkish" flowers.

The following new nomenclature is, therefore, proposed:—

Flowers white ..... *Drosera indica* Linn. var. *alba*.

Flowers red ..... *Drosera indica* Linn. var. *rubra* Parandekar et Diwan.

Biology Department,
Rajaram College, S. A. PARANDEKAR.
Kolhapur, M. G. DIWAN.
*September* 16, 1943.

1. Cook, T., *Flora of the Bombay Presidency*, 1901. 2. Mayuranathan, V., *Bulletin of the Madras Govt. Museum*. 3. Pfleiderer, I., *Glimpses into the Life of Indian Plants*. 4. Roxburgh, W., *Flora indica*, 1874.

## PRODUCTION OF ELEMENTARY SULPHUR BY REDUCTION OF SULPHATE THROUGH BACTERIAL AGENCY

IN the course of investigations on microbiology of some anærobic bacteria at the Imperial Agricultural Research Institute, New Delhi, an organism, which reduces sulphate to elementary sulphur, has been isolated both from soil collected from the bottom of an irrigation channel and materials from the anærobic fuel gas plant set up at the chemical laboratory. Although the reduction of sulphates to sulphides in the presence of organic matters has been known for a long time, no mention has been made in literature of any organism producing elementary sulphur by reduction of sulphate. The organism appears to be a new one of the kind as is evident from the morphological characteristics and biochemical tests. The organism is a gram negative, non-spore forming short rod. It grows in Dunham's solution in the presence of sucrose, lactose, maltose, raffinose, levulose, mannite, salicine, and glycerine with no gas and acid. The organism ferments glucose with production of gas and acid and reduces nitrate to nitrite and ammonia. It neither curdles nor peptonises milk. It does not reduce litmus milk. The organism grows well in Van Delden's lactate asparagine liquid medium of the following composition:— $K_2HPO_4$ 0·5 gm., Sodium lactate 5·0 gm., Asparagine 1·0 gm., $MgSO_4$ or $CaSO_4$ 1·0 gm., $FeSO_4$ Traces, and Tap water 1,000 c.c. In this medium about 30-35 per cent. of sulphur present in calcium sulphate is reduced to crude elementary sulphur in about a week's time. For the estimation of crude elementary sulphur 50 c.c. of the inoculated culture medium were evaporated to dryness on water-bath. The dried mass was treated with carbon disulphide and then filtered on a tared porcelain dish. The carbon disulphide was then evaporated to dryness. The substance extracted by carbon disulphide was then weighed as crude elementary sulphur. Further test for sulphur was made by oxidising it with nitric acid and precipitating the sulphate with barium chloride.

The production of hydrogen sulphide could not be detected at any stage as no blackening of lead acetate paper occurred during the course of reduction.

The possibility of this organism producing sulphur from sulphate by composting with organic matter is being studied. A paper on the subject will be published later.

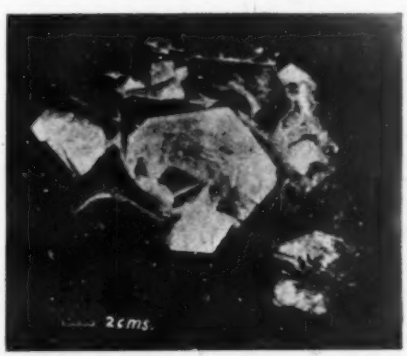
Imperial Agricultural
Research Institute,
New Delhi, S. C. DATTA.
*September* 15, 1943.

## PYRITE CRYSTALS FROM THE ALMORA DISTRICT, UNITED PROVINCES

PYRITE is a widely distributed mineral and occurs in formations of various ages, and its crystals are quite common. However, on account of the large size of the crystals the above occurrence is worthy of record.

The crystals occur in greenish schistose phyllites at two localities, Chowkoree (29° 50·5′: 80° ·2′) and near the bank of Sarju river E.N.E. of Khani (29° 47′:70° 47·5′).

From the former locality the crystals are cubes, which are somewhat distorted and show




a pseudo-tetragonal symmetry. The edges of the largest crystal measure 19 mm. One of the crystals showing the pseudo-tetragonal symmetry can be seen towards the right in the photograph.

From the latter locality, in addition to the cubic crystals, pyritohedrons are also common. The largest crystal in the collection (see photograph) has octahedral faces on it. The longer edge of the largest pyritohedral face measures 31 mm. and the edge of the octahedral face measures 6 mm. The crystals are grown one into another giving an aspect of inter-penetration twinning. The intergrowth of crystals seen in the photograph weighs 1,005 gm. A chemical analysis of the crystals gave:—Sulphur 53·46 per cent., Iron 45·36 per cent.

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University of Lucknow, R. C. MISRA.
*September* 29, 1943.

## INFLUENCE OF POTENTIAL AND NATURE OF RADIATION ON THE NEW LIGHT-EFFECT IN CHLORINE UNDER ELECTRICAL DISCHARGE

EARLIER results[1,2,3] on the production of a new light-effect, *viz.*, $\Delta i$ the diminution on irradiation of $i$ the discharge current, were observed under conditions selected chiefly to reveal the main phenomenon, within the range and sensitivity of the then available indicator. This precluded a wide-range investigation of the nature of $\Delta i$ changes, when all except one of the determining factors were unaltered. Thus, *e.g.*, whilst $\Delta i$, the light-effect, was quite marked over a wide range of V the applied potential using a violet light-filter, it was just detectible with red, employing any of the familiar, intense light sources and maximum V. This limitation was absent using the Cambridge A.C. microammeter, which has both improved and simplified appreciably the whole technique of the study of this new phenomenon.

Fig. 1 records results for $\Delta i$ observed with the above instrument as V was varied over an

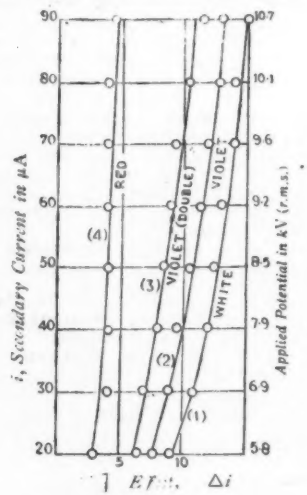


FIG. 1

appreciable range; the corresponding values of the secondary current are also indicated. The light source was a 200 watt bulb run at 180 volts. In agreement with earlier results[2b] for $\Delta i$ due to a fixed V, it is seen that the light-effect with the violet filter (curve 2) is substantially similar to that for unfiltered white light (curve 1), and that comparatively, $\Delta i$ due to red is markedly low. The use of a pile of two violet filters (curve 3) as against one (curve 2) illustrates the effect of a reduction of intensity in diminishing $\Delta i$.

In relative units, the total incident energy corresponding to the white, violet, violet (double filtered) and red was 34·1, 16·5, 8·7 and 22·2 respectively. These results suggest that frequency is more important than the intensity in the production of this phenomenon.[2,3] That violet is more absorbed than red by chlorine is an additional factor.[2b,3] It may also be mentioned that within the limitations of the means at our disposal this light-effect was found to be negligibly small in the infra-red.[3] It is interesting that the general influence of an increase of V in increasing the light-effect in chlorine is but small and is comparatively sensible under the white or the violet light, when $\Delta i$ is large.

Benares Hindu University, S. S. JOSHI.
*September* 2, 1943. P. G. DEO.

1. *Curr. Sci.*, 1940, **9**, 536. 2. (*a*) *Nature*, 1941, **147**, 806; (*b*) 1943, **151**, 561. 3. *Proc. Ind. Sci. Cong.*, Pres. Address to Chem. Sec. (1943), pp. 70–75.

## THE INDUCED OXIDATION OF HYDRIODIC ACID WITH VANADATE AS INDUCTOR

THE reaction between vanadate and hydriodic acid has been studied by numerous workers but the course of the reaction is not yet definitely established. Perkins[1] and Gooch and Curtis[2] among others found that the amount of iodine liberated was in excess of that corresponding to the equation

$$V_2O_5 + 2HI \rightarrow V_2O_4 + I_2 + H_2O.$$

We have conducted experiments to determine the total amount of iodine liberated in the presence of air under varying concentrations of vanadate and hydrogen ion. It was found by us that when the hydrogen-ion concentration was kept constant the discrepancy between the experimental and theoretical amounts (according to the above equation) of iodine increased with the decrease in the concentration of vanadate; when the vanadate concentration was kept constant the discrepancy increased with decreasing concentration of the hydrogen ion.

Ramsay[3] stated that the theoretical amount of iodine corresponding to reduction of pentavalent vanadium to the tetravalent stage is indeed obtained when the reaction is allowed to take place in an atmosphere of carbon dioxide excluding the presence of air. Experiments conducted by us in an atmosphere of carbon dioxide and in vacuum under widely varying concentrations of vanadate and hydrogen ion showed that the amount of iodine liberated in the absence of oxygen corresponds quantitatively to reduction to the tetravalent

stage. These experiments rule out the suggestion of earlier workers[4] that the excess liberation of iodine observed in the presence of air may be due to the reduction of the pentavalent vanadium being carried beyond the tetravalent stage. We have carried out experiments to see if this excess liberation of iodine in the presence of air is due to (*a*) the simple autoxidation of hydriodic acid by atmospheric oxygen catalysed by tetravalent vanadium or (*b*) the oxidation of hydriodic acid by atmospheric oxygen induced by the primary reaction between vanadic acid and hydriodic acid. We found that at the hydrogen-ion concentration employed in the experiments the liberation of iodine due to cause (*a*) is negligible and cannot account for the enormous liberation of iodine actually observed. The excess liberation of iodine observed in the presence of air is, therefore, due to the induced oxidation of hydriodic acid. We also found that the induction factor (F)

$$F = \frac{\text{Number of molecules of hydriodic acid oxidised by oxygen}}{\text{Number of molecules of hydriodic acid oxidised by vanadic acid}}$$

varies with concentration of vanadate and hydrogen ion. Recently we[5] reported that oxalate ion catalyses the reaction between vanadic acid and hydriodic acid. The presence of the catalyst also influences the magnitude of the induction factor.

Chemical Laboratories,
Andhra University, C. R. VISWANADHAM.
*September* 25, 1943. G. GOPALA RAO.

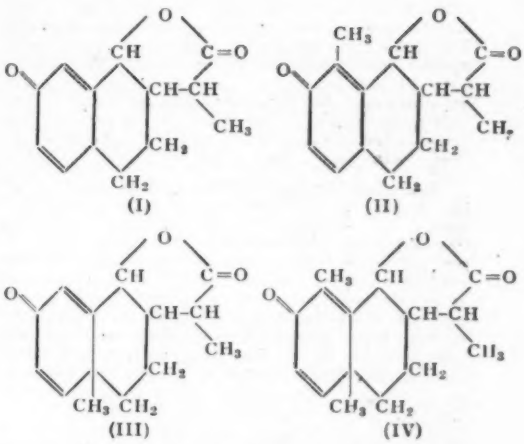
1. Perkins, *Amer. J. Sci.*, 1910, **29**, 4, 540. 2. Gooch, and Curtis, *Ibid.*, 1904, **17**, 4, 41. 3. Ramsay, *J. Amer. Chem. Soc.*, 1916, **38**, 2389. 4. Ditz and Bardach, *Z. anorg. chem.*, 1915, **93**, 97. 5. Viswanadham and Gopala Rao, *Curr. Sci.*, August 1914, No. 8, 229.

## AN ABSOLUTE ASYMMETRIC SYNTHESIS

AN absolute asymmetric synthesis consists in the preparation of an optically active molecule without using at any stage of the synthesis an optically active reagent and without using any of the methods of resolution. Some cases of asymmetric synthesis using polarised light, etc., have been reported but an unequivocal synthesis without the use of such agencies has not been reported. Such an asymmetric synthesis has now been observed for the first time in our work on the synthesis of santonin and related compounds.

The synthesis of santonin (IV) has already been reported.[1] Using similar methods we have prepared compounds (I), (II) and (III).

As all these compounds were expected to be racemic an attempt was made to resolve them by the usual methods. Compounds (I) and (II) were really racemic and could be readily resolved through their strychnine salts into the dextro and lævo forms. The dextro form of (I) had $[\alpha]_D^{28^\circ} = +112$ and its lævo form




had $[\alpha]_D^{28} = -112$. Similarly the dextro form of (II) had $[\alpha]_D^{28} = +158{\cdot}5$ and the lævo form had $[\alpha]_D^{28} = -158{\cdot}5$.

The synthetic samples of (III) and (IV) were on the other hand optically active with $[\alpha]_D^{28} = -104$ and $[\alpha]_D^{28} = -154$ respectively. (IV) was converted into the sodium salt and fractionally precipitated as the strychnine salt by strychnine hydrochloride or strychnine. From the strychnine salt precipitated, on decomposition, it was possible to regenerate (IV) having $[\alpha]_D^{28} = -172$ (m.p. 171) identical with natural santonin. The filtrates from above gave a lævo rotatory compound having $[\alpha]_D^{28} = -108$ (m.p. 171) but no dextro rotatory isomer could be isolated. Thus an absolute asymmetric synthesis had occurred at some stage of the synthesis of these compounds. Our previous statement that synthetic santonin was racemic, therefore, requires correction. A careful study of the various stages for optical activity revealed that asymmetric synthesis must have occurred either during methylation of the formyl derivative or during its subsequent condensation with the ketone. All the rotations were determined in chloroform solution.

Further work on the mechanism of this asymmetric synthesis is in progress.

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N. L. PHALNIKAR.
B. V. BHIDE.
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Maharaja Pratapsinh
Chemical Laboratory,
Sir Parashurambhau College,
Poona,
*November* 11, 1943.

1. *Curr. Sci.*, 1943, 150. 2. *Rasayanam*, 1943, 8, 201

# REVIEWS

**Theoretical Organic Chemistry.** By J. B. Cohen. Revised Edition by P. C. Austin. (Macmillan and Co., Ltd., London), 1942. Pp. viii + 622. Price 10/-.

The latest revised edition of this most popular book on Theoretical Organic Chemistry should be welcome to all students beginning the study of the subject. The book is noted for its clear and concise exposition of the subject which is supported by a large number of carefully selected experiments for illustrating the main reactions of Organic Chemistry. Nearly sixty pages of additional matter have been added since the first edition appeared, and descriptive details for the preparation of important compounds have been included. The general arrangement of the original edition has been adhered to, the enlargement of the text being mostly confined to Parts II and III. Two new chapters have been introduced in Part I—one on stereo-chemistry, and the other on the electronic theory of valency. These two chapters have replaced those on ureides and proteins, the latter having been transferred to Part III, in which a new chapter has been added on compounds of biological importance. In this, the beginner is given a general idea of some of the recent developments which have taken place in vitamins, hormones, plant-pigments, etc. Apart from these, slight additions are noticeable in almost every chapter in the book. The electronic theory of valency, which has now attained such importance, might have been given a more prominent place in the book, and electronic formulæ for organic compounds and interpretations on the basis of this theory of many of the important reactions of organic compounds, such as those of nitro-paraffins, iso-nitrites, etc., might have been given throughout the book in appropriate places. These are, however, minor deficiencies, and the book may be safely recommended to our students of the B.A. and B.Sc. (Pass) classes.

B. B. D.

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**Organic Chemistry.** By Sarkar and Rakshit. (H. Chatterjee & Co., Ltd., Calcutta). Revised and enlarged second edition. Pp. 576. Price Rs. 6.

This book is meant to be a text-book in organic chemistry for B.A. (Pass) students. It covers almost the same course as given in *Theoretical Organic Chemistry* by Cohen or *Organic Chemistry* by Perkin and Kippings, Vols. I and II.

The book is divided into 46 chapters of which the first five deal with the general methods such as purification of substances, detection and estimations of elements and determination of molecular formulæ, etc. The next 24 chapters deal with aliphatic portion while the last 17 chapters are devoted to aromatic compounds. Each chapter begins with the most important members of a group of organic compounds followed by general methods of preparation of such compounds and notes on their industrial importance. At the end of each chapter are given exercises bearing on the subject-matter dealt with in the chapter.

A special feature of the book is the pointed reference it makes to the industrial importance of the substances to India. On this account the book makes a stimulating reading even to the general public. The treatment is complete and the information given is up to date. The illustrations are attractive, the printing is clear and the typographic errors are surprisingly few. The book can be heartily recommended as worthy of consideration as a text-book for B.A. (Pass) students.

K. S. N.

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## FISHES OF LAHORE

**Fauna of Lahore—5: "Fishes of Lahore".** By Nazir Ahmad, *Bull. Dept. Zool. Panjab Univ.*, 1, 253-374; 49 figs. and 1 map (July 1943). (Published by the Punjab University.) Price Rs. 4.

The *Ad hoc* Fish Committee of the Advisory Board of the Imperial Council of Agricultural Research, in its meeting of the 9th November 1937, in considering practical development of fish industry in India, expressed the opinion that

> "In order to effect development upon satisfactory lines, it was necessary to carry out local surveys of the amount and class of fish available and in this connection proper identification of the fish caught in each area was essential."

From the above it will be clear that the proper study of the fish fauna of a locality is a condition precedent to the development of its fishery resources. Viewed from this standpoint, the publication of *Fishes of Lahore* is a welcome addition to a number of articles that have appeared in recent years, such as *Fishes of Northern Bengal, Fishes of Travancore, Fishes of Mysore, Fishes of Hyderabad,* and the results of faunistic surveys carried out by the Zoological Survey of India from time to time in different parts of the country.

The author of the *Fishes of Lahore*, off and on, spent two years in making a thoroughly representative collection of the local fishes occurring within a radius of about fifteen miles from the Zoological Laboratory, Government College, Lahore. After a preliminary identification of the species with Day's standard works on Indian fishes, he took the trouble to compare his specimens with the named material in the collection of the Indian Museum and to consult literature in the library of the Zoological Survey of India for nomenclatorial purposes. A certain amount of information on the bionomics and life-histories of the species studied are also given either from personal

observations or from earlier records. The result of all this labour is the production of a thoroughly reliable and fully illustrated handbook of the fishes of Lahore, which should prove invaluable to fishery administrators interested in the fish supply of Lahore. Owing to the limited scope of the series, "Fauna of Lahore", of which *Fishes of Lahore* is the fifth contribution, the author had to leave out such species which though marketed in Lahore, are imported from far off stations. Fortunately in reviewing the records of fishes from Lahore, the author has indicated a number of such forms, the addition of which to the 49 species described by the author can give an almost complete picture of the fishes sold at Lahore. Though undertaken purely as an academic piece of research at a University centre, a monograph of this nature has great practical value, as it can form the basis of works like *Common Food Fishes of Shanghai* and *Common Marine Food Fishes of Hong Kong*, which have already been reviewed in this *Journal*. For the collection of fishery statistics, a work of this nature is indispensable.

Both the author and the publisher are to be congratulated on this excellent production which, though not entirely free from blemishes, is beautifully printed and well got up.

S. L. H.

## RELIGION AND SCIENCE

**Science, Cause, and God.** By J. B. Freeman, The Hogarth Press, Madras. (The Author, Apud Auctorem, Chingleput), 1943. Pp. 341. Price Rs. 7-8-0 or 12*sh*.

Notwithstanding the fact that the relation between Science and Religion is perhaps the most persistent problem which challenges human intellect and to which evidently no permanent solution could be found satisfactory alike to the scientific and the religious conscience, any attempt to focus or concentrate attention on the different aspects of the problem surveyed historically or genetically and to suggest some suitable way out deserves unreservedly to be welcomed by the world of scientists and religionists. Father Freeman's work, the second revised and enlarged edition of which is now under notice, is a systematic and sustained attempt to analyse as fully and completely as possible the philosophical and scientific implications of the concept of *Cause* undertaken with the palpable motive of demonstrating that *God* is to be understood as the *Cause* of the Universe. Part I, entitled the "Survey of Knowledge", contains *five* chapters devoted respectively to "Mathematics", "The Concrete Sciences", "The New Outlook in Physics", "The Human Sciences", and to "Relativity". Part II, which contains *eighteen* chapters, constitutes the main portion of the book dealing with the analysis of the concept of Cause. I would invite the attention of your readers to Chapter 3—particularly to page 174, and to Chapter 12—specially to page 258 for an unequivocal statement of the author's central or cardinal position. "This first cause Uncaused, this first perfection Unperfected, this pure form we call *God*" emphatically states the author. There are other statements in other contexts which emphasize the same truth.

When statements like these are categorically made difficulties begin to confront those engaged in scientific research understood strictly within the jurisdiction of laboratory discipline devoted to qualitative and quantitative analysis. Unless supremely significant reservations are made and re-interpretations of the concept of Cause resorted to a strict orthodox laboratory scientist would be perfectly entitled to contend that an uncaused First Cause is right though riddled with contradictions. For, among the well-known weapons of experimental analysis nothing would seem to secure under the established conditions of verification such an uncaused Cause. The author has found from Whitehead, Jeans, Eddington and others to show that some of the modern scientists have abandoned the *Deterministic Outlook*, and recognised the existence of "intuition of free will". That would not take one very far or far at all. The human free-will on even a superficial analysis would appear readily as hemmed in on all sides with countless restrictions, and as surrounded by a veritable barbed wire fence of determinisms, evolutionary, hereditary, environmental, and even individual. Assuming for the sake of argument that somehow there is human free-will, that would lead to no evidence whatever in support of the existence of an uncaused First Cause. A difficulty like this cannot be lightly or light-heartedly dismissed. Christian Theists like the author have to face it and remove it. So have the Indian Vedantins. But, neither the vedantic nor the Christian theological solution can be forced down the throat of scientists who may contend that laboratory evidence for the existence of an uncaused First Cause is not forthcoming. The author has traced the countless vicissitudes of the concept of Cause since the days of Hume, and after a discussion of post-Humian ramifications has brought down the discussion to contemporary philosophy to Bergson, Radhakrishnan and others. Here again the conclusions lead us nowhere and the criticism of the different European and other Western system-builders found in Radhakrishnan's *Reign of Religion in Contemporary Philosophy* on which the author sometimes relies for support is totally unfounded and untenable as the main argument stands vitiated by a deliberate and disingenuous assumption that Absolute Idealism or Monism is the only rational or fashionable philosophy of life and that pluralistic and theistic systems owe their origin to the interference of religious prejudice with strict metaphysical speculation!! While the author presses Radhakrishnan's critique of Russell into the service, he himself clean throws overboard the self-same Radhakrishnan's Absolute Idealism or Monism. From this elaborate excursion into the works and arguments of these "thinkers" only one rational conclusion can be drawn. The conclusion is that the peculiar type or variety, or species of causality which points to *God* as the Uncaused First Cause of the entire creation

would by its very nature and constitution *never admit of laboratory verification* which is the one goal of all modern scientific methodology.

Not in any manner or by any means to disparage the undoubtedly excellent work of the author but, merely to illustrate definite difficulties that confront the inquirers, I would invite the author's attention to a remarkable and sensational treatise by Dr. Bentner (London, Chapman and Hall, 1939) entitled *Life's Beginning on the Earth* (reviewed by me in a previous number of *Current Science*), towards the end of which the conclusion is thus indicated: "..... life is not a sort of miraculous separate entity, imposed on our earth by a spirit or an invisible something ... Life is one of the developments of the Universe governed by the general laws of nature" (p. 222). If all sciences that pursue the methodology of the laboratory control refuse to proceed beyond the conclusion just indicated, *they cannot be blamed*. For, on the plane or level of investigation conducted through the instrumentality of qualitative and quantitative analysis, no other conclusion would at all be possible.

This need not, would not mean any disparagement of all metaphysical effort and endeavour that have characterised the higher thought of mankind throughout the ages. Other methods, other methodologies, other weapons, other hypotheses, and other criteria of verification would have to be admitted to be functioning and operative, and it would be *ultra vires* to question or challenge the validity of these from the standpoint accepted by the laboratory disciplines. Trite as it may seem the need of the hour is that *Religion should grow more religious*, and *Science should grow more scientific*. It is *not* the other way about. The contention that Religion should grow scientific and that Science should grow religious is totally untenable.

Modern Psychology has admitted a multilateral or multi-dimensional development of human personality and complete critical caution and circumspection and strictest scientific scrutiny would co-exist in perfect harmony with religious belief. There is no use of forcing down the throat of a scientist the religious beliefs and solutions. Nor is there any of forcing down the throat of the religious the solutions of science. Sir Richard Gregory, the talended Editor of *Nature*, in his arresting volume entitled *Religion in Science and Civilization*, has argued with striking emphasis, clarity, and breadth of philosophical and scientific vision that both Science and Religion are the products of evolution of *homo sapiens* on this planet and both should be treated and evaluated accordingly. One cannot dictate to the other. For, any attempted dictatorship of the one over the other spells dire disaster.

I desire to make just one more comment in conclusion. The author speaks of first establishing causality and then arriving at the existence of God (p. 281). There is exactly the rub. He refers to a stage "prior to causality" and styles it the potential speaking likewise of potentialities "able to give" and "able to get". But, then, the potentialities *qua* potentialities must have a being which has to be explained and evaluated in reference to the all-comprehensive concept of causality. Are the potentialities *Uncaused*? For, the author definitely writes "prior to causality". Even the use of "prior" would indicate the existence of TIME *not necessarily* "per accidens".

Be that as it may, the author should endeavour to stabilise his notions of Indian theories. He would have "Vaiseshika", the "Satkarya-vada", and "Vivarta-vada" correspond to "Scientific", "the Metaphysical", and the "Mystical" points of view (p. 253). These *are not* mutually exclusive species of the same genus, for, each can be well claimed to be all patterned into *triune*. *Vivarta-vada* definitely connotes *illusionism* but, mysticism does *not* necessarily mean any illusionism at all. Dr. Freeman's book is an effervescent stimulus, and stimulant a crisp challenge to modern scientific and philosophical thought. I expect scientists and philosophers would properly respond to it—not armchair pseudo-scientists and pinchbeck philosophers, but, those of the two categories worth their salt.

R. NAGA RAJA SARMA.

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**Cretaceous Rocks of South India.** By. L. Rama Rao. (Lucknow University Studies XVII), 1942. Pp. 78. 4 Figs.

This publication contains two lectures delivered at Lucknow University Palæobotanical Laboratory in December 1940, which give an excellent conspectus of the knowledge we possess of a number of isolated patches of marine cretaceous strata in Trichinopoly District, near Vridhachalam, Pondicherry and in the vicinity of Rajahmundry. These rock-formations give us a glimpse into one of these rare and transient episodes in India's geological history when the Deccan along its marginal belts was submerged under the sea. Mr. Rama Rao has dealt with each individual cretaceous outcrop in detail, giving its extent, stratigraphic succession, its rock and fossil contents and the geological horizon indicated by the recent examination of the micro-fauna and flora, more particularly the latter, in which Mr. Rao and his collaborators have made a useful contribution. Niniyur division of the Trichinopoly Cretaceous is, on the evidence of the fossil algal contents of the nodular limestones as well as of the embedded flints and cherts, assigned an age astride of the youngest Cretaceous and basal Eocene.

The four figures show the geographical distribution of these interesting rocks and give a helpful picture of the areal extents these rocks must have spread over at a time when the eastern shores of India, from Assam to Trichinopoly, had suffered their deepest invasion by the waters of the Southern Sea.

D. N. W.

# SCIENCE NOTES AND NEWS

**Quinine Substitute.**—Dr. U. P. Basu, Bengal Immunity Research Laboratory, Calcutta, writes:—

In August issue of your esteemed Journal, *Current Science* (1943, No. 8, p. 236), it has been mentioned that Laverain is being manufactured on a bulk scale in India, and it will be a really effective substitute for quinine. The main substance present in this tablet would be the quinoidine which is usually a black pitch-like mass and consists of the residual amorphous bases left in quinine factories after the four primary cinchona alkaloids and their reduction products, the dihydro bases, have been extracted. It may be cheap febrifuge but its value as an anti-malarial drug is small. Generally it is used as an accelerator in vulcanising rubber. As such, it is a question whether in a country like India where malaria takes a large toll of life and where the shortage of quinine is being so keenly felt by the population, a product like Laverain might be considered to be a substitute at all for quinine.

**Rainfall in Mysore in the Months of September and October.**—The months of September and October are the wettest months in the year for the Maidan parts of the State. On an average about 40 per cent. of the annual rainfall is gauged in these two months. In a number of years it has been noticed that a comparatively dry September is followed by a wet October and *vice versa*. To see if the relation is real, the following correlation coefficients were determined between the rainfall for these months for all the districts in the State. The data for 50 years (1893-1942) have been taken into account.

| Districts | Cor. coefficients |
|---|---|
| Bangalore | − ·38 |
| Kolar | − ·38 |
| Tumkur | − ·35 |
| Mysore | − ·31 |
| Chitaldrug | − ·40 |
| Hassan | − ·01 |
| Kadur | + ·33 |
| Shimoga | + ·31 |
| State | − ·25 |

According to Fisher's table V-A in *Statistical Methods*, correlation coefficients with the value 0·35 and above are significant for values of $P = ·01$. Thus the relation is significant for the Maidan districts except Mysore. For the Malnad districts—Kadur and Shimoga—the positive correlation indicates that the rainfall departures for September and October have generally the same sign but the correlation is below the level of significance.

The relation may be explained as follows. The Maidan parts of the Mysore State have heavy falls of rain just before the setting in of the South-West Monsoon, *i.e.*, in May or just before the withdrawal of the Monsoon, *i.e.*, in September or October. Earlier withdrawal of the Monsoon means comparatively heavier total for September and later withdrawal, a heavier one for October.

**Palaeobotany in India.**—The fourth Report on the Progress of Palæobotany in India for the year 1942, published annually by Prof. Birbal Sahni of Lucknow, with the co-operation of a Committee, has been recently issued. As usual the materials studied are arranged in the order of age, and range from the Carboniferous to the Pleistocene formations in India. Most of this work we owe to the Lucknow School of Palæobotany—except that on the Cretaceous and Tertiary algæ, which is being done at Bangalore. Among the several items of research recorded in the Report, special mention may be made of the following: (i) Mr. D. D. Pant's investigation of the Bacchus Marsh Tillite of Australia, which has yielded a surprisingly rich microflora of species which must have lived contemporaneously with the glaciation; and similar investigations of the microflora from the Dwyka tillite of South Africa. (ii) Further contributions to our knowledge of the Rajmahal flora—especially the recent discovery at Onthea by Messrs. V. B. Shukla and G. S. Puri, of about a dozen well-preserved flowers of *Williamsonia*, referable to at least two species. (iii) More detailed studies of the flora of the Deccan intertrappean series by Prof. Sahni and co-workers, which have resulted in several fresh discoveries of fossil plants of outstanding interest and importance, such as the presence of a new genus *Rodeites* (allied to the modern *Regnellidium*) which represents the first undoubted fossil record of the Marsileaceæ; the occurrence of *Sahnianthus*, one of the best preserved flowers, the study of which confirms the suggestion already made that this flower belongs to the plant of which the fruit has been known as *Enigmocarpon Parijai*; and the description of the first and only known fossil *Chara, sensu stricto* named *Chara sausari* from the intertrappean cherts near Sausar. The Report also gives a brief account of the further contributions made by Mr. S. R. N. Rao (Bangalore) to our knowledge of the rich algal flora from the Cretaceous beds of the Trichinopoly and Pondicherry areas; he has also recently taken up the study of the fossil algæ from the early Tertiary Dunghan limestone of Baluchistan.

The Report under review gives a fuller and more readable account than in previous years, of the palæobotanical work being done in

1. Henry, *The Plant Alkaloids*, 1939, p. 404 (Churchill Ltd). 2. Sollmann, *A Manual of Pharmacology*, 1936, p. 562 (W. B. Saunders Co.).

India and contains several illustrations (text-figures and plates) of the more interesting finds. The usefulness of this publication is thus considerably enhanced, and we have no doubt that the Report will be much valued and appreciated by all workers in the field of palæobotany.

**Imperial Agricultural Research Institute, New Delhi.**—The following students of the Institute have been awarded the diploma of the Institute (Assoc. I.A.R.I.) after completion in September 1943 of their two-year post-graduate course and the acceptance by the Institute Council of theses sumbitted by them:

*Botany*: (1) Mr. A. V. Gokhale, (2) Mr. N. S. Reddy, (3) Mr. Abdul Alim, (4) Mr. Mohd. Sulyman, (5) Mr. M. B. Patkar, (6) Mr. R. K. Bansal.

*Chemistry*: (1) Mr. S. K. Vardhan, (2) Mr. M. L. Mathur.

*Mycology*: Mr. M. K. Hingorani.

*Entomology*: Muzaffer Ahmad.

*Sugarcane Breeding*: (1) Mr. Harkaran Singh Rana, (2) Mr. Rais Dulah Khan Emazie.

**National Institute of Sciences of India.**—At the meeting of the Council of the National Institute of Sciences of India, held on the 26th October 1943, in the rooms of the Royal Asiatic Society of Bengal, Calcutta, the following were declared to have been elected Ordinary Fellows:—

(1) Dr. E. L. G. Clegg, D.Sc., M.I.M.M., Director, Geological Survey of India, Calcutta; (2) Dr. A. K. Das, D.Sc. (Paris), (Dr. d'etat), Meteorologist, Meteorological Office, Calcutta; (3) Dr. P. De, M.B. (Cal.), F.R.C.P.E., Professor of Physiology, Medical College, Calcutta; (4) Mr. Verrier Elwin, Fellow, Morton College, Oxford, Honorarary State Anthropologist, Bastar State, Gorakhpur, C.P.; (5) Prof. G. P. Majumdar, M.Sc., Ph.D. (Leeds), Professor of Botany, Presidency College, Calcutta; (6) Dr. B. Mukerji, M.D., D.Sc. (Michi.), F.A.Ph.S. (U.S.A.O.), Offg. Director, Biochemical Standardisation Laboratory of Government of India, Calcutta; (7) Prof. Raj Nath, Ph.D. (Lond.), D.I.C., Professor of Geology, Benares Hindu University, Benares; (8) Dr. H. Rakshit, D.Sc. (Cal.), F.Inst.P., Assistant Lecturer in Physics, Calcutta University, Calcutta; (9) Mr. M. S. Randhawa, M.Sc., I.C.S., Deputy Commissioner, Rae Bareli, U.P.; (10) Prof. R. C. Ray, D.Sc. (Lond.), F.I.C., Professor of Chemistry, Science College, Patna; (11) Dr. S. B. Setna, Ph.D. (Cantab.), F.R.M.S., Fishery Officer, Bombay; (12) Dr. P. V. Sukhatme, Ph.D., D.Sc. (Lond.), Statistician, Imperial Council of Agricultural Research, New Delhi; (13) Dr. G. R. Toshniwal, D.Sc., Lecturer in Physics, Allahabad University, Allahabad; (14) Dr. B. P. Tribedi, M.B. (Cal.), D.B. (Lond.), Professor of Pathology, Medical College, Calcutta, and Bacteriologist to the Government of Bengal, Calcutta.

## MAGNETIC NOTES

Magnetic conditions during October 1943 were less disturbed than in the previous month. There were 8 *quiet* days, 20 days of *slight* disturbance and 3 days of *moderate* disturbance as against 12 quiet days, 16 days of slight disturbance, 1 day of moderate disturbance and 2 days of great disturbance during the same month last year.

The quietest day during October 1943 was the 14th and the day of largest disturbance was the 24th.

The individual days during the month were classified as shown below:—

| Quiet days | Disturbed days | |
|---|---|---|
| | Slight | Moderate |
| 6, 13–16, 18, 21, 23. | 1–5, 7, 8, 10–12, 17, 19, 20, 22, 25, 27–31. | 9, 24, 26. |

No magnetic storm occurred during the month of October 1943 while two magnetic storms were recorded during the same month last year.

The mean character figure for the month of October 1943 was 0·84 as against 0·71 for October 1942.

M. V. Sivaramakrishnan.

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"Indian Farming", Vol. 4, No. 5.

## BOOKS

*Science, Cause and God.* Second Edition. By J. B. Freeman. (Higarth Press, Madras), 1943. Pp. 341. Price Rs. 7-8-0 or 12*sh.*

*Testing Radio Sets.* Fourth Edition. By J. H. Reyner. (Chapman and Hall, Ltd., London), 1943. Pp. 215. Price 15*sh.*

## ERRATA

Vol. 12, p. 233, note entitled "The *Kurram santonica*": para 1, line 7, *for Kurram santonin read Kurram santonica*; at the end of the note, *for* 'M. A. Qazilbash' *read* 'N. A. Qazilbash'.

Vol. 12, p. 279, note entitled "Virus Diseases of Potatoes in India": para 1, line 7, *for* 'particularly' *read* 'particularly'; para 2, line 7, *after* 'to' *add* 'plants with', and *after* 'symptoms' *insert* a comma; line 14, *for* 'such' *read* 'the'; para 3, line 6, *for* (*Solanum* virus 2)' *read* '(*Solanum* virus 2)[1]'; para 4, line 5, *after* 'U.P.' *add* 'and elsewhere,'; second column, para 2, line 2, *for* colon after 'plants' *use* full stop.

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